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America's First Aeronautical Magazine

AVIATION

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How's and why's in engineering this radical conception—now followed by two personal planes—told by Douglas' Carlos Wood. (Page 37)



HOW TOUGH IS THIS TRANSONIC BARRIER?

NACA's John Stack presents new analysis indicating piloted aircraft can break through with less-than-anticipated difficulty. (Page 43)



REFRIGERATION A MUST FOR JETS

Over-500-mph. speeds make cooling an essential. Here's why airframe and power plant designers must work closely with equipment engineers. (Page 49)



MAINTENANCE PLANS FOR NEW AIRCRAFT

How Panam set up special organization for efficient integration of new types still to join its fleet. (Page 94)



Introducing the Pirate

Sleekness is the keynote for the Navy's newest jet-propelled shipboard fighter, the Chance Vought XF6U Pirate, now being readied for service with the fleet. Another Vought product, the revolutionary structural material, Metalite, makes possible mirror-smooth skin surface and lighter weight to boost the Pirate to the "well over 500-m.p.h." class and provides the extra sturdiness required by near-sonic speeds.

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Curb Crashes Now—Or Else

IN ADDITION to its economic problems, air transportation is in the midst of a wave of crashes which could easily destroy the public acceptance gained by nearly two decades of hard work and brilliant achievement. No expenditure of time, money, or effort is too great to end this epidemic at once.

There is no time for long, drawn-out investigations, blame passing, explanations, excuses, or any of the familiar procedures. The outrage simply must be stopped, and quick.

When you are sitting up there in the coop, with fuel running low and fields closing in like flames, it doesn't matter whether ILS is better than GCA in the opinion of some expert sitting comfortably at the ground. It doesn't matter whether the rule book says you should try Philadelphia, New York, Hartford, or Boston, if you can't get into Washington. And there isn't time to change the temperament of the pilot who would rather risk 50 odd ticks including his own than be saved by lower paid personnel on the ground.

It is quite true that all of the recent crashes could not have been avoided by more effective landing aids. Neither were they all chargeable to scheduled air transport. But the customer makes little distinction in such matters. And the victims are none the less dead.

It is also true that Army or Navy GCA facilities

were available to many of the planes in recent trouble and are constantly available along the North Atlantic seaboard and in other places. It is also within the pilots' province to declare an emergency and act accordingly.

There is no time to wait for future landing aids which may or may not be satisfactory to all concerned. There is no time to wait even for the experimental GCA installations now being made in the East. Unless there is a much better reason than is now apparent, all pilots should be checked out on GCA immediately and instructed to use it when necessary. In addition quick steps should be taken to clean up the business in operating procedure which has been creeping into the control of many scheduled, non-scheduled, and private aircraft.

These steps must be taken regardless of who is hurt. Human lives and the future of an industry are at stake.

Regardless of who is to blame, the airlines are faced with the problem of regaining lost public confidence against the opposition of older and more experienced interests. They cannot win this battle by the backing heavy type of publicity effort. First they must get their houses in order to be deserving of public support. Then they must tell the world about it—and keep on telling their story in a solid, long term program of superior public education.

From Service Merger—To Air Policy

THE PROPOSED MERGER of the armed services is a matter of great importance to all segments of the aviation industry. The task of coordinating the services will be hardly upon the shoulders of the reorganized Congressional committees. Most encouraging is the desire of the Armed Forces Committee to key military policy to foreign policy. In this approach we may, at last, find the means for establishment of a national air power policy.

If an aviation subcommittee is included in the Appropriations Committee, the whole matter of air power expenditures can be studied soundly. It should arrive at the realization that the cost of maintaining our armed forces is shared by commerce and industry. At the same time, the armed forces must to support free commerce and indus-

try. And these expenditures also contribute to the strength of our national economy.

The armed forces themselves appear to be thinking of their future organization in terms of missions instead of weapons. This clarifies the role of aircraft in the air forces and in the land and sea forces. Aircraft are not weapons but vehicles for fast transportation of all weapons.

It is the duty of the Congress to appraise these new principles carefully. The industry should watch these developments closely and be ready to contribute all possible assistance to our legislators in this important work.

Yoshi E. Zwiller
EDITOR

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sult to the stirring chapter covering the fighting history of the Aerojet Jato in World War II.

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AVIATION, February, 1947



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be serviced while in operation. Unit is
intended for ground-air communica-
tions. Removable inverted "T" trans-
mitter unit is built on a welded steel
base chassis with vertical aluminum
channel and steel lower panel. All heavy
components are mounted on steel wire

put. Acoustic peak detector is claimed to prevent over modulation of 15 dB increase in input level or over 3% increase in total distortion. Speed of limiting action is 1/100 sec. Positive and negative peaks are limited. Minimum audio input level is 0.2 milliwatts across 600 ohms. Con-

Holtzman, William C. 1994. 4

Bentley's, Bentley's Books, Bentley's... 19



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Service families interviewed by reporter on the wing of a Sinclair airplane.



At left, group of service wives and children board American Overseas Airlines plane at New York's LaGuardia Field for flight to Germany.

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Illustration: Tubes—Carbon—Alloy—Stainless Steel. Size: Welded Seamless Steel Tubing; Cold-chamber High Pressure; Integral Iron-Bronze or Tubing; Mechanical Tubing—Pressure Tubing—Tubing for Compressor and Heat Exchanger Applications

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AVIATION, February, 1947



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AVIATION, February, 1947



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THE AVIATION NEWS

30 Knock Accord on A-N Mergers—Fueled by a decision to create a co-equal air force, joint news of the month was word that Army and Navy heads had finally arrived at a basis for unification of the armed services. The long battle over this vital question was resolved when President Truman persuaded in his call for a compromise. Army won its request for a Secretary of National Defense, while Navy, on its side, was granted right to retain certain controls—such as that over the Navy—which it had stood firm against relinquishing. Final implementation awaits action by Congress, which is considered to be favorably disposed.

General over all air functions, both combat and transport, except for specialized missions of the other two services, is to go for the new co-equal Air Force—also giving it fighting-tones, domestication. Army, under the agreement, would have full control over land fighting and service personnel, together with air and water transport as required, and Navy would have similar jurisdiction in air, retaining its naval aviation and Marine Corps, also right to operate specialized air transport. Marine arm reinforcement was retention of its own air components.

Related under the new Secretary of National Defense, each of the three departments, Army, Navy, and Air Force, is to have its own military head and also its own secretary. Averted at this writing are the numerous clarifications which will more clearly define the new military structure and the precise responsibilities of bi-departmental leaders.

31 Budget Demands Figure—Recommended for AAF early procurement is a solid estimate to \$720 million, including contract authorization, compared with \$372 million obligated for that purpose in fiscal '47. Navy budget gets a cut from \$908 obligated in '47 to \$203, including contract authority, for aircraft.

AAF research and development is boosted from \$948 in '47 to \$111.58. Guided missiles, maintained for the first time in a budget, gets \$1.5. Surprisingly, funds for industrial mobilization, considered important by AAF, are dropped from \$1.5 to about \$1.6 million.

Baker's total, though only 10% of Navy's total, is down from \$507.7 in '47 to \$516 in '48. Ordnance departments of both Army and Navy get funds, part of which go for projectile research.

NACA is asked for \$29.7 next year, to \$16.4 next fiscal, with emphasis on Cleveland engine lab, which gets \$14 in present \$10 this year. CAA would be asked \$23.4 for regulating and servicing civil aviation. CAB's rate is down 12.3 to \$3.5.

32 Industry's '46 Record—Aircraft industry moved about \$1 billion in its first full postwar year—four times that of 1915. AIA reports output of lightplanes (December estimate) at 35,000, military planes 1,000, and transport (including all two-engine units) 410, total 36,550 for '46. Gross or completed airplanes (last two months estimate) at \$307 million. Engines, propellers, accessories, parts and conversion work, large total to \$750 million. Balance is military development contracts.

Industry should sell 2,500 more planes in '47. Delivery of transports will drop, but convert will rise, due to larger ships. If Congress sends enough funds, military develop-

ment will increase. Output of general planes is seen declining.

33 Cauter Mexico Conference—With more outside this winter, flying a fast expanded some three times over that of previous days, the public is critically wondering about application of all possible safety techniques. CAB-CAA and the airlines agree that any accidents are too many. More time Congress spends into investigating action.

Thus there are renewed efforts to eliminate all possible risk. Chief among them a further report of final ground control approach. AAF is flying B-17s and C-54s daily between two CCA stations, one at Wilmington, Okla., near Dayton, and one at Andrews Field, near Washington. Results, which are available to the airlines, are deemed satisfactory.

CAA, instead in some quarters of concentrating too long on its instrument (fixed wing) landing system and neglecting CCA after Army and Navy made it work, has gained ATA and Air Force in installation of CCA at New York, Washington, and Chicago. These begin operation this week.

Navy, which "bafled" fighters should occur with order during the war, has 14 surplus CCA sets, and AAF has 130, which are offered to CAA for airline use at a cost of \$5,100.00.



AROUND THE SUPERSONIC CORNER

NACA concept for defense ultra speed transport depicts transport 3,000 m.p.h., 1,500-ton-range craft which engineers believe can be successfully produced within next 10 years. Power would be supplied by three turbojets, four turbojets, and four jet-engine turbojets. As shown in flight view, Dap's proposed ship would feature 45-deg. sweptback of wings and tail surfaces. Drawings (shown) disclose details of fuel storage, streamlined passenger compartment, transport in tail, and retractable nosewheel landing gear. (NACA photos.)



SCHOOL LEVEL LINK

Here is new junior instrument trainer produced by Link for use in school classrooms. In new price level it has wide appeal to schools. The School Link Trainer will introduce to young graphic presentation of flight techniques. Device, free to pitch, bank, and turn in response to stick and rudder pedal movements, has simplified panel of seven instruments. Available in simplified and higher unit for instructor/pilot cockpit, possessing five engines, eight air and electrical heating systems, and still engine. Cruising speed is 87 mph, top speed is 105.

30th In Action—Legislation on air transport, for better or worse, has passed the two houses, and will be sent to the Senate. Right now in the 86th Congress: (1) A resolution requesting recognition of services, specialties, and administration of all U.S. Airlines; (2) Chairman Wallace White (R, Me.) of Senate Interstate & Foreign Commerce Committee asks Sen. Owen Brewster for a study of international air transport; (3) Sen. Pat McClellan (D, N.J.) has bills pending, requiring that bilateral international air transport agreements be passed on by Senate in tandem; and that U.S. domestic and foreign airlines be separated; (4) McClellan will reintroduce but kill first an Air-American line line qualification of all U.S. foreign airlines; (5) Sen. Bill McClellan (D, N.J.) reintroduces a measure calling for independent civil aeronautics authority and safety boards and (6) is a bill to be offered by McClellan limiting CAB's power to control airlines.

There will be more bills in both House and Senate, probably including one or more on the authorities for national transport.

Continuation on Cargo—Independent Airflight Act, in an oral agreement, called for immediate action on CAB's proposed exemption for aircraft (less 70% of low-cost airlines) which would permit unrestricted air freight services, with application pending, to fly cargo on a common carrier basis until 60 days after CAB grants or denies them certificates. If Senate House, moved for the Amendment, confirms the legislation would be out of business before CAB acts on the certificates. He said the certificates actually are handling freight as a sort of stop express, at a low Airlines reply there is no emergency requiring a demand in CAB's normal procedures. They say the airlines, in their current financial circumstances, need the freight revenue.

Formulate Factors—CAB's North Central Airlines decision of Dec. 31 was the first of 1916, totaling 25,000 to 30,000 route miles. Operations of the new franchise as far as paid by new title data indicating whether the short haul system is widely accepted, as will pay its way.

CAB expects four or five reports in early March. Decision by Lockheed and Boeing and to produce better and Model 417 models, respectively, will usually narrow operators' choice of equipment. Some are operating DC-3s, which increases their problem of finding suitable airports.

State of Airport—AAR-CAA has started its federal aid airport program with plans to spend \$55 million in 1947 on about 600 fields, including Class 1, 254 new and 33 improved; Class 2, new 109 and 177 improved; Class 3, 44 new and 153 improved. About half of fund will go for Class 2, because they are needed by localities, and because private flying also can use them. Construction on Airports will run total up to nearly \$140,000,000. Spent on roads, bridges, and other related improvements will match federal money with additional \$37,700,000, making '47 total of over \$71,000,000. Next year, larger city airports will get more money.

Canadian Notes—A. Van Canada, Toronto, has been assigned large part of wartime production plant at Model 401, for work on gas turbine aircraft engine, development of which first took over from government's Turbo Engines, Ltd. . . . Fleet Aircraft & Mfg. Co., St. Catharines, Ont., had second recent change of controlling interest when Vincent Vining Corp., Toronto, and controlling interest in Fleet Aircraft & Mfg. Co., Toronto. Company continues making Fleet Canada plane.

WORLD DATA

ENGLAND—Victory has delivered first of 30 pilotless type supersonic aircraft to Air Ministry for testing. Powered by rocket engines based on V-2 principle, top speed is expected to be between 800 and 1,000 mph.

AUSTRALIA—Battle between private industry and government-owned TAA (Trans Australia Airlines) is continuing. Each group has been capitalizing on others and neither suffered by the other in widely used airfields. Also changes of personnel putting an end to duty. Australian Government plan to split operations of private and state, and to establish for scheduled public goods TAA, it gives evidence of private least in cost means than Australian aviation.

CHINA—Now at part will permit Chinese airlines to enter U.S. at its Pan American line (Hankow) and at New York, while U.S. lines will serve China by way of North Pacific route as well as by Mid-Pacific and around-the-world route coming from India. . . . Official reports state that connections are being maintained between China and Russia by Sino-Soviet Airlines Corp., which operates four DC-3-type craft on 400 mi. run between Shenyang and Alima. Also Air First seven months of '46 showed 151,000 mi. flown and 57,564 passengers carried.

INDIA—Steps are being taken for establishment of all-India air communications network. Officially named Aeronautical Communication System, it will operate a combination of facilities acquired from private companies together with extensive facilities transferred to it by USAAF. . . . New railways by government on surplus aircraft and supplies have made it possible for surplus aircraft and private owners to obtain necessary parts to place all aircraft into flying condition. Previously such parts had been restricted to four operating airlines.

SWEDEN—SAS (Scandinavian Airlines System) expects delivery in its order for 17 DC-6s in late '47. Ten planes go to ASA, 5 to SLL, and 2 each to DDL (Drottning) and DNL (Norrby). Planes will be used on trans-Atlantic and other international routes.



Design Development Of the Douglas XB-42*

By CARLOS C. WOOD, Chief, Preliminary Design Section, Douglas Aircraft Co.

What the problems were—and how they were solved—in getting a truly aerodynamic airplane in the air less than 30 sec. from start of design. Presenting basic data of extreme value in engineering future craft utilizing these new aerodynamic features.

EXHAUSTIVE CONSIDERATIONS of all latest type of aircraft military weapons, Douglas proposed construction of a new type bomber to the AAF in May of 1945. The war situation was then just beginning to shift, but there was a long road still ahead.

We had finally taken Guadalcanal, the North African campaign was just over, and the attack was driving rapidly to produce the weapons needed for victory. Airborne effort was being poured into aircraft production, but we were beginning to realize the difficulties in having a large stock supply by air.

It appeared that one way of shortening the war would be by the construction of a bomber of the type in which we had been pushed back to the fact that it might not be desirable to consider the entire long range bombing job with airplanes that available or soon to be available in the security circumstances without seriously weakening our military facilities.

Accordingly our work was for an efficient military weapon that would

permit increasing the heavy long range bombing attack with minimum material effort. This formidable strategic situation required a minimum operating radius of at least 2,000 mi.—the target, Tokyo.

Security requirements for increased range as minimum basic load always result in large empty, doubling either range or bomb load, resulting in far more than doubling of power requirements of very long range aircraft, an aircraft with very large payload, outside the present solution of

a slowly increasing series, since structural efficiency tends to decline with increasing size, as does aerodynamic efficiency. Demands for more horsepower grow ever higher because of physical limitations on size of operating base and the requirement for an adequate level of performance, and these combine to require more fuel, more crewmen, more crew members, and thus more considerable difficulties in overall design with increasing size of aircraft.

In the XB-42 we planned a big step in aerodynamic, structural, and power plant efficiency which would result in a drastic reduction in airplane size for a given range or bomb load. With high aerodynamic, structural, and power plant efficiency, it appeared that it should be possible to develop a small, high speed versatile airplane capable of being maintained and operated by a small crew, using only a relatively small amount of fuel (then being purchased on military transport), requiring only a minimum amount of base of its speed, and requiring minimum

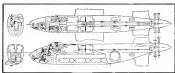


Fig. 1. Internal profile and cross section of Douglas XB-42.

*Based on a paper presented before the Aeronautical Society, 1946.

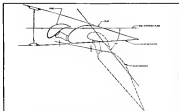


Fig. 4. Section through wing showing flaps up and down.

there was a very small wake passing through the propeller disk from wing and tail sections, and it was found to produce no noticeable propeller vibration. The next least important source of propeller vibration was the wake from the extended landing gear, as shown in Fig. 4. Extended landing gear are in the horn's line, and though a noticeable amount of trouble was reported from wings causing the propeller disk, the effect of the wake, although noticeable, was not enough to cause any serious prop vibration.

Next least important source of propeller vibration comprised two interrelated items, namely the wing flap and cooling doors. As shown in Fig. 5, cooling doors were located in the upper portions of the wing in slots maximum pumping effect from pressure distribution to the wing. These doors opened toward to maintain speed of flow over the wing. As shown in Fig. 5, flaps were of double-dotted type, suspended by linkage from the wing. When flaps were deflected, the position of the wing was such that the wake passed through the propeller disk.

As shown in Fig. 7, wake from extended flaps is quite powerful at the propeller disk. This induced considerable vibration and occasioned some wear on this area. However, at speeds at which flaps are in operation or at which the cooling doors are open there was no question of any propeller structural failure. Some pilots indicated roughness was more noticeable landing, others thought it was about that of normal flight.

Major source of propeller vibration was found to be the wake of the open bomb bay. As shown in Fig. 8, when the bomb bay is open, there is a cavity

in wake as the plane, half as deep as the fuselage, and 40% of the length of the plane. As the bomb bay must be open at any flight speed up to planned flight, this source of vibration may be extremely serious. Extensive

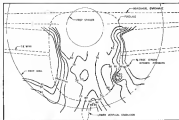


Fig. 7. Wake, flaps extended, landing gear up.



Fig. 8. Cross and longitudinal sections showing extent of bomb bay.

power of the wake can be seen in Fig. 9. The wake was found to be subject to some control by simulating most of the spillage at the rear of the bomb bay by means of slots and reshaping. The other means taken were to minimize wake effect by use of wing-section bomb doors, thus shortening the critical period of open bomb bay, and by streamlining of the aft gear box, to minimize effects of the vibration both on the propellers and the airplane. Flaps in form two gained in the investigation of these vibration problems it is believed any future plane will have only routine trouble from this source.

Structuring aerodynamic problems were generally confined to control surface balance and damping. Internal sealed balance were used on the control surfaces, and although trouble was annoying, they were generally minor in the provision of suitable amount of balance to give suitable hinge moment characteristics throughout the wide speed range of the airplane. The trouble encountered in the above system where they were compensated by the fact that the re-

proportional plane had a control system with sensitive friction. This vibration could not be controlled in the X-32 because of lack of time. But it has been corrected in the X-33.

Shaping work was on two systems, engine induction and cooling. For the first time in our knowledge, duct-type scoops were used in the engine induction system and the problem was solved by provision of suitable boundary layer kinds in the ducts. The cooling door problem was complicated by the fact that the arrangement was solved by provision of suitable boundary layer kinds in the ducts. The development of suitable ducting concentrated on the provision of proper flow for cooling with minimum drag and proper exhaust flow over the wing so minimum pressure was paid in wing drag and wing lift. Duct development moved progressively from the initial type to the final type, as shown in Fig. 10.

Power plant installation, although by far the most radical step taken, presented surprisingly few difficult problems, primarily because of our deliberate attempt to make the installation nearly an exact reproduction of conventional components. Fig. 11

reflects the general arrangement. Two Allison V-1710 engines were installed immediately behind the pilot's compartment, with the outboard of each at about 20 deg to the vertical, and the engine and its a few degrees to the rear. Power was transmitted from each engine to its own propeller through five lengths of shafting, each attached to the end in the full P-38.

Clear induction and duct drive was through a modified V-3420 counter-rotating gear box to Curtiss right- and left-hand propeller propellers, which were especially modified to permit individual governing and separate control. Duct problems of alignment, etc., naturally arose during engineering and construction, but no trouble has ever been encountered from the engine and drive system. Incidentally, the shafts and bearings all appear to be in excellent shape after more than 600 hr, at the test stand, as well as over 100 hr, at flight.

Airflow from the duct problem, as difficult as was encountered in flight operation of the cooling system, but considerable development was necessary for proper ground cooling. Its solution was available for ground testing because of the location of the propellers

behind the tail, and accordingly ground cooling fans were necessary. One electrically-driven fan was provided for the Pratt & Whitney motor for each engine, as well as one for each of control. The final control system for ground cooling fans provided that electrical energy be supplied from the battery and generator uniformly for each engine when the weight of the plane was on the nose gear while the air pressure of the propeller engine exceeded 25 psi. Ground-usable development was required to obtain motors that would not burn out—this turned out to development of suitable cooling and cooling provisions for the individual motors. Apparently the fan was good as an trouble has been reported from the ground cooling system since Oct. 1944.

Next, the X-33 presented only rather routine duct problems—even considering the rather complicated leading gear—except for amount. As the airplane is small and fast, it appeared from complete analysis of possible attack techniques that the only ducting design required would be a rather limited one to the rear. Pressure at the propeller in the tail complicated the issue. The initial thought was to mount one or two

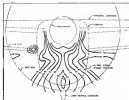


Fig. 9. Wake, flaps and landing gear retracted, bomb bay open.

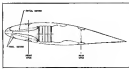


Fig. 10. Wing section showing collector duct designs.

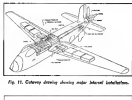


Fig. 11. Gateway showing ducting under internal installation.



Fig. 12. Gateway showing wing hand design.

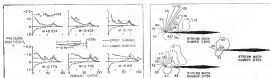


Fig. 4. Pressure distribution for some attack. Fig. 4. (right) Typical freestream measurements for leading-edge region, some attack.

during the course of experiments were by Liebeck, Deloy, and Row planes (at the MACH 4 x 15 in high-speed wind tunnel) to obtain data in steady transonic aircraft problems.

The flow in part of the transonic regime for a 4-in. chord approximate-type airfoil is illustrated in Fig. 5. At low Mach numbers, supersonic flow occurs at the leading edge. With increase of speed, sonic disturbances are seen in the flow outside the separated zone. These disturbances are apparently traveling forward as indicated by Fig. 6 and 8 as the downstream airfoil. These disturbances in the wake of the inverted shock, which in appearance is much like that found for subsonic airfoils. With further increase of speed, however, there is a radical change in type of flow. The apparently upstream disturbance takes the sharp corner at the leading edge and flows along the upper surface. The separated flow which occurs at the lower surface disappears. There is an oblique disturbance which appears to originate in the high velocity region around the nose of the airfoil, and this is first followed by shock or compressibility bubble of the type found for subsonic airfoils. The forward oblique disturbance does not, however, penetrate to the airfoil.

Even though the streamlines speed is below the speed of sound, the phenomenon suggests a Prandtl-Meyer turn. A Prandtl-Meyer turn is a non-physical explanation, because the movement of the leading edge oblique supersonic velocities. Pressure-distribution diagrams for a 4-in. chord MACH 15-17(10)-(70)-(10) airfoil are shown in Fig. 3. The existence of a narrow zone of supersonic velocity at the leading edge, as shown by the pressure distribution diagrams, possibly, if we fix attention on the region immediately at the leading edge, the possibility of a Prandtl-Meyer turn.

Proceeding with this reasoning, the validity of this hypothesis is easily investigated. If a simple type of

Prandtl-Meyer turn occurred, we can establish the maximum lead Mach number at which the flow attachment occurs. When the angle of attack is less than the semicircle of the leading edge, the flow attachment would occur with a compressible in the flow. When the angle of attack is greater than the semicircle of the leading edge, the flow attachment would occur with a compressible in the flow. For the lower angle of attack, except the minimum lead Mach number for flow attachment would be that given by the angle of turn required, supposing that the Mach number immediately behind the turn is about 1.8. For the higher angle-of-attack range, the maximum lead Mach number immediately behind the corner would be given as a function of the angle of turn. From the Prandtl-Meyer relations, as given in Green and Gen Tenth, in *Aerodynamic Theory*, and elsewhere, the leading-edge turn angle, the minimum lead Mach number, and the corresponding Mach number immediately behind the corner have been calculated as a function of angle of turn. The flow example of the only, an understanding of the simple Prandtl-Meyer turn, as a possible explanation, we found. For example, for an angle of attack of 4 deg and minimum lead Mach number 1.8 immediately ahead of the turn, the selected Mach number behind the corner is 1.11 (from experiment, 1.1).

In making this comparison of the placement, it was not possible to determine the lead Mach numbers near the leading edge from the pressure-distribution diagrams because it was impossible to place pressure taps in the model sufficiently close to the leading edge. Pressure data for this region were, therefore, obtained by reflecting wall within the tunnel walls, and pressure in the field of flow, as well as close to the airfoil surface near the leading edge, were obtained. Typical free field measurements for the leading edge region are

illustrated in Fig. 4. For the MACH 15-17(10)-(70)-(10) airfoil at a 4 deg. angle of attack, for which the data are presented in the figure, the flow attachment is at the upper surface at an angle of attack of about 0.35. For this stream Mach number and higher values the free field measurements show, immediately behind the leading edge, a very rapid increase in pressure, followed by a rapid decrease to a nearly constant lead supersonic Mach number extending back a considerable distance along the upper surface of the airfoil.

Considering the Prandtl-Meyer phenomenon, these pressure surveys indicate a local turn of direction of the flow sufficiently greater than given by the simple geometry of the stream direction and at an oblique angle. Since the airfoil is at an angle of attack, the stagnation point is on the under surface. The flow must effectively turn through the leading-edge turn angle, and the stagnation point is on the under surface. This would mean expansion actually, a flow condition using Liebeck's concept shows a separation of flow. A local separation of the flow occurs, does not permit, the flow along it immediately behind the leading edge. These results at the nose of a "bubble" around which the flow flows. The existence of this "bubble" provides a possible reason why the flow can follow.

The forward oblique disturbance is a compression shock. Examination of the free-field measurements shown as indicated in Fig. 5, that this shock has very closely along the contour line of the maximum Mach number in the field. It might be supposed, therefore, that this disturbance represents the local change of flow direction that occurs at the rear end of the "bubble" at the nose. This supposition may be reasonable, however, because the disturbance is originated in the flow at a distance out from the airfoil.

The free-field measurements, Fig. 4, show that very close to the surface

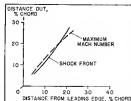


Fig. 5. Position of forward oblique disturbance and location of maximum Mach number in the flow field with some attack.

of the airfoil, in the nose which the disturbance does not penetrate, the region of highest Mach number and consequently low temperature is very small. Thus the actual time for which the air remains at extremely low temperature is short, whereas at a distance out from the airfoil the gradient of temperature in the shock wave is very much less and the air is at a longer time at low low pressures. It was therefore concluded that the forward disturbance could be a compression shock and that its failure to appear in the nose zone is the airfoil was due to the extremely short time interval for which the air and its contained molecules were at very low temperatures. Further study, however, indicates that this disturbance is not a compression shock. First, if a compression occurred, the flow field to the rear of the disturbance, because the local temperature remains very low, could be expected to show evidence of fog, which actually was absent. Second, after investigations made in the MACH 4-in. high-speed wind tunnel established that, for each Mach number as near as this disturbance, the airfoil remains constant of the amount but apparently higher than it was in these experiments if conditions is to occur.

There remains uncertainty as to the exact origin of this disturbance. It may be possible that there are large lead sections, such as those found at the sharp leading edge as flow experiments are now without giving rise to a compression immediately. Such a flow might be considered as a rarefaction and a compression wave may be close together as to neutralize each other. The flow, in effect, then occurs without evident discontinuity. On pressure data obtained from the airfoil, the disturbance gradient in Mach number becomes much smaller and the flow, behaving in the well-known manner, gives rise to the compression dis-

turbance shown by the experiments. The second oblique disturbance, which exists near the nose and terminates in the normal shock, takes with the normal shock and the probable thickening boundary layer (Fig. 5), is similar in general character and is presumably the same phenomenon found with conventional subsonic airfoils. Elimination of the separated region at the leading edge of the sharp edge airfoils has shown in some instances apparent effects on the lift and drag characteristics. Fig. 3 gives a comparison of the lift and drag characteristics for a subsonic and a supersonic profile for a range of subsonic speeds. These data illustrate the influence of the flow phenomena found for the sharp-edged profiles on the lift and drag characteristics. The rapid rise of lift coefficient and the reduction of the drag coefficient values of a Mach number of approximately 0.95 by the data for the sharp-edge circular air profile correspond to attachment of the flow to the upper surface. At angles of attack other than zero these data show

low variation in characteristics with Mach number and, within the portion of the transonic range covered by these experiments, somewhat better characteristics for supersonic profiles. The general aerodynamic characteristics have not been discussed, but the indications shown by the data presented in Fig. 6 are representative. It appears that supersonic airfoils (using, of course, supersonic-type profiles) may experience less difficulty in passing through transition regions than had been expected in previous information. This is due to the phenomena in the flow about the leading edge whereby the flow separation, found at low speeds for the expansion-type profile, is eliminated. There may also be possibilities for improvement of efficiency of high tip speed propellers through incorporation of the sharp-edge profile for elements of the blades in the shock-stall region. First that the flow is a considerable degree, attached to the upper surface at Mach numbers much less than 1.0 suggests less drag coefficient loss as the Mach number passes through 1.8. Data indicated by the following photographs suggest the possibility of characteristics equivalent in behavior to that of Mach number twenty greater than 1.8.

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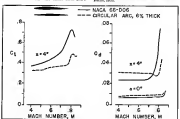


Fig. 6. Lift and drag characteristics of a supersonic and a subsonic type airfoil.

These Test Procedures Keyed Jet Engine Advance

By E. E. STOCKLEY, Aircraft Gas Turbine Engineering Section, General Electric Co.

How comprehensive proving methods—such as following reciprocating engine practice, some involving entirely new techniques—were devised to attain maximum strength and thermodynamic performance in jet propulsive power plants.

DEVELOPMENT OF THE COMPRESSOR and propellant engine in the present state of perfection required a large variety of tests on component parts and the complete engine. Some of the tests have a counterpart in reciprocating engine testing but many are entirely different because of the new problems encountered.

These tests divide into two principal groups: tests to prove mechanical strength and endurance, and tests to determine thermodynamic performance. Consider first the mechanical tests of the component parts. The compressor impeller or rotor is checked by running to some predetermined overproof. This is done as is shown in Fig. 1.

The rotor is hung on a small frame which is an evacuated tank and the assembly driven up to speed by a small velocity turbine. Careful measurements are made of the amount the impeller or rotor stretches at various speeds by tak-

ing the assembly up to speed in steps. Similar tests are made on the disk-hub laminated turbine wheel. If wheel trouble develops, it may be because of too large amounts of winds to destruction. This helps in obtaining the best material, best forging technique, and proper heat treatments, or it may be necessary to simplify test procedures both of turbine wheels to make certain that quality is maintained.

In engine of the 1-40 and T-0-500 size, easily obtained in such destruction tests is several million foot-pounds. Tests on 1-40 wheel blades turn them that three consecutive wheel tests will produce an 11 to 12 inch ring of laminated steel under plate. Through the cooperation of the U. S. Navy we have obtained a series of 12 inch thick laminated steel plates from which a propellant ring has been made that has taken a very large number of tests.

In order to determine the proper conditions existing between destruction tests on wheels at room temperature and the short-time burning speed of wheels operating at running temperature conditions, a high-temperature wheel destruction test was developed.

In this setup the turbine wheel and the shaft are operated in their own bearings under no-load conditions. The turbine discharge is connected to an evacuating system, and hot gases are fed to the turbine wheel through a standard turbine diaphragm and combustion chamber. Air in the combustion chamber is taken in on the left-hand side of exhaust nozzle passage.

In this test the wheel speed and the operating temperature of the gas surrounding the wheel are controlled independently by the proper adjustment of exhaust pressure and fuel to the combustion chamber.

In addition to the short-time burning test, it is necessary to make long time endurance tests under actual engine operating speeds and test conditions. To obtain the proper correlation between various kinds of wheel materials, it is desirable to make endurance runs under postulated maximum mechanical conditions of stress and temperature. The desired test temperature and speed are usually controlled through the arbitrary rating of the machine.

To obtain this, an engine with a reduced diameter impeller and an exhaust jet nozzle is used. The operating speed and temperature are controlled independently by the proper adjustment of fuel flow and air flow from the compressor discharge.

All of the fuel system accessories, such as main fuel pump, shutoff fuel pump (where used), altitude control device, the speed governor, control valves, stop valve, and fuel nozzles must be thoroughly developed and tested for both performance and life endurance, under the fuel wet which they will be required to operate.

To date, all necessary tuning has been done at normal room temperatures. To determine the effect of low temperatures on differential expansion of the many close fitting parts, on seal operation, and on effect of low-temperature fuel on the operating

characteristics, low-temperature high-altitude test stands are being built. These will be employed for the operation and endurance testing of all fuel system accessories.

To determine the ability of the seal to withstand phase movement, the finished turbine wheel and shaft are sometimes subjected to gyroscopic loading both in which the turbine wheel and shaft are operated at normal speed and rotated about an axis perpendicular to their axis of rotation at some specified velocity of precession. This is continued until either bearing failure, the shaft fails due to fatigue, or a specified time has elapsed. To date no test stands are available for gyroscopic testing of the complete engine.

The structural strength of the engine frame, bearing supports, and engine transmission supports against gyroscopic loads and free pull-and-load is checked by statically loading the frame at various points, using weights, cables and pulleys. In these tests, deflections are measured at various points, strains are measured by tension gauges, and ultimate strength is measured by carrying the test to destruction.

A large number of tests are made to determine the performance of various component parts. These include complete performance investigations on various forms of impellers. Diffusers, housing vanes, turbine blades, and other flow passages, must be flow checked. Turbine design is determined in a similar way to determine the effect of standard diaphragm blade shape, leading edges, areas, angles, and clearances. Various shapes of exhaust nozzles are tried in order to obtain maximum velocity and jet pressure, to convert from the turbine-wheel discharge.

Besides the tests on the component parts, many tests are run on the complete engine. Purpose is to establish, for development purposes, the operation, performance, and endurance of the complete unit under all operating conditions. Included are tests to establish the performance of different fuels, combustion-chamber liner life, operation operation, combustion efficiency, bearing operation and life, effect of altitude, oil consumption, or vibration effect of fuel nozzle balance, effect of combustion-chamber nonuniform distribution, exhaust-nozzle distortion and life, burner and wheel life, maximum safe operating speeds and temperatures—and many more. There are also the normal Army and Navy type tests, proof tests, and acceptance tests.

Cells for checking the complete engine have changed considerably since the first tests were constructed several years ago. Fig. 2 is a cross-section of one of the first cells constructed for jet-propellant engine testing. In these initial cells, no attempts were made at sound-proofing.

Combustion air to the cell is measured by the intake air flow nozzle located in the upper left-hand corner. The air flows across the center of the cell is connected to the jet nozzle on the right by means of a glass duct. The purpose of this duct is to form the burning looking air discharged from the rear of the engine to pass over the top of the cell walls and mix evenly with the incoming air—rather than flow back and feed directly into the rear compressor inlet, where it would be difficult to obtain a satisfactory average inlet temperature.

The engine is supported upon a swinging base, controlled by four rods from roof beams. The jet nozzle is taken on two horizontal rods on the upper motor line to a 12 ft pole in the rear of the cell. Bottom of the pole leads into three-horsepower hoists, which are of approximately 100 sq. in. area, hinged about, and which lead directly into recovery systems. Repeated observations over a considerable length of time have shown these hoists to maintain their efficiency to less than 1%. The exhaust pipes are in ground level of glass duct.

Because the early cells were located among a group of non-airtight buildings, a 48-in. ducted labyrinthine duct was constructed, the exhaust jet nozzle of the engine is taken to the right-hand side of Fig. 2. No trouble has been experienced with these ducting walls on 516 and 1200 engines; but on 1-40 engine cell, it is a matter of burn, not only the duct but also the 12-in. steel plates attached down. However, 12-in. steel plates, welded into approximately 12-ft. x 12-ft. pieces, have stood up satisfactorily.

The three principal faults of the cell are: (1) Very high operating

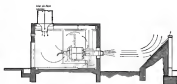


Fig. 2 Type 1-40 engine in test cell without exhaust silencer.

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noise level; (2) exhaust gases feed back into the compressor inlet under certain conditions; and (3) engine cooling air is fed back into the compressor inlet, resulting in high average inlet temperature.

To correct the first two major objections, inlet and exhaust silencers have been added. When air-flow measurements are made, the engine exhaust pipe is sealed off in the normal manner. The exhaust gases pass out through the exhaust-pipe recovery section to the silencing diffuser section, to the water cooling spray, to the exhaust pressure control dampers, to the exhaust cooling, and to the exhaust hot pipe, which discharges the gas vertically upward approximately 30 ft above ground level. The exhaust duct shows little chance of getting back into the inlet where air is drawn in, approximately 12 ft. above ground level.

Recent tests are of the type shown in Fig. 3. The engine is mounted on a swivel base to take angles of the 1-40 and T-0-500 size. The aircraft silencer and exhaust silencer have been constructed similarly to those used in conventional aircraft engine tests. Exhaust-gas sealing is achieved by using approximately two to three parts of seal air to one part of exhaust gas.

An expanding tube in the horizontal section of the exhaust-duct duct reduces the pressure in the exhaust-gas recovery chamber (just following the exhaust jet nozzle of the cell) to a pressure somewhat below that existing in the forward section of the duct test cell. This allows a pressure drop across the cell walls. Reminder of the pressure drop is between the rear section of the test cell and the exhaust-pipe recovery chamber.

These pressure drops make sealing easier to pass through and around the cell. The engine, thus, can be tested at the cell and in the exhaust-

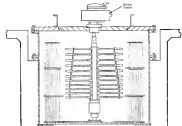


Fig. 3 Grouped test for T-0-500 compressor-rotor assembly.

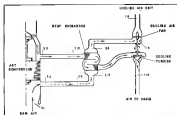


Fig. 2. Schematic of a "direct" air cycle system only one known to author to be flying. Air (and fuel) from turbine compressor is first cooled to about "effective" ambient temperature in air-cooled heat exchanger, then is expanded to expand pressure in expansion turbine, resulting in discharge temperature substantially below dry ambient. Pervox flow (which is used to pull oxygen air through heat exchanger without any assistance of fan, if any pressure is available by ambient flow, but pressure rise can be used by mixing drug in contact section.

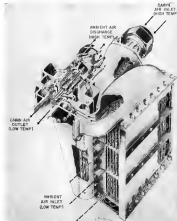


Fig. 2.4. Catenary drawing of tracheal realizations of "simple" system shown in Fig. 2

experiences an increased air temperature due to the warm effect.

"Bulk" temperature rise is simply expressed as:

$$\Delta T = \frac{P}{500} \quad \text{where } \Delta T = \text{temp. rise in } \frac{\text{deg. F}}{\text{hr}}$$

$P = \text{true air speed in mph}$

The airplane skin temperature is approximately the ambient $+ \Delta T$, and any air taken into the airplane will be similarly heated. Accordingly, the "effect on ambient" temperature for our desert analogy becomes the atmospheric ambient plus the "real" max.

If this picture of discomfort is so adequate, consider the fact that the poor pilot is likely to be wearing the equivalent of a fur coat. Wearing light clothes is dangerous of high altitude flight is included in the mission; if he has to halt out at high level, he can freeze to death in his parachute.

In recent fast, cockpit temperatures of over 150 deg. F have been recorded with an atmospheric temperature of only 80 deg. F. Obviously, human endurance may be exceeded. If high speed flight at low altitude is contemplated, the airplane designer must include cockpit cooling in his plans. It is just as important as its treatment in military operations.

A complete consideration of possible rocket-cooling means is beyond the scope of this present discussion, but it is worthwhile to touch on approaches which differ from air cycle methods. The simplest system, readily used in wartime piston engine fighters, is that of carrying along some ice. Dry ice is preferable to H_2O , since less weight is

Another solution is to adapt the super cycle of the household refrigerator to the job—standard in green or conditioning palette.

However, these plans fade out when the magnitude of the cooling job is represented. Repeated analyses indicate that weight and bulk considerations greatly favor the use of air expanding through a turbine, or turbofan. This conclusion is reached in spite of the greater power required for air-spill engines.

To avoid looking too far over the horizon, this article is limited to all cycle systems which bleed their supply of compressed air from the compressor of a gas turbine. Systems operating from an alone or supplying their own compressed air being to separate fields. The latter type are now in use for transport. Perhaps conditions will change, but the bleed-off systems look the best for the problems with which we are now faced.

If we were to not use "ideal" goals, we

might be to have a cable temperature adjustable between 65 and 85 deg. F., with relative humidity controllable between 30 and 90%. This goal, of course, would have to be met with effective ambient temperatures from +200 to -55 deg. F. and true ambient air

ability from 5 to 100%. To accomplish all this, we must be able to: Heat and cool air, add or subtract moisture, and provide a sufficient ventilation rate of fresh air.

It must first be admitted that the "ideal" seat seems unlikely of achievement in military aircraft because of weight, bulk, and drag penalties attendant. However, if uncomfortable but endurable conditions are shown by design at extreme flight conditions, the pilot will be quite comfortable most of the time.

In practice, bleeding hot air from the compressor seems to take care of heating, and adding moisture seems to be out of the question because of additional weight and bulk involved. Furthermore, extraction of moisture to reduce cockpit humidity is not yet being used in military aircraft. This would seem to back the really sophisticated solution to the refrigeration job.

If the criterion is an "undesirable" condition, and it is presumed that any actual low altitude atmospheric condition is undesirable on the summer-day pressure side, it would appear that a system that will reduce cabin temperature to the true ambient value is acceptable for the altitude design space. This implies that no moisture need be separated, since provided ventilation rates are so high that moisture addition by personnel may be neglected.

The choice of design conditions involves a thorough understanding of the sludge and its intended use, and superficial analysis will result in bad systems, regardless of the merits of the equipment applied. In the design of a system, it is necessary to select the following conditions:

1. Highest atmospheric temperature at sea level likely to be encountered.
2. Highest airplane speed compatible with (1).
3. Highest ambient relative humidity compatible and coincidental with (1).
4. Highest acceptable cockpit temperature compatible with (1), (2), and (3).

1. Heat flow from airplane skin to ambient air conditions.

2. Host added to cockpit by other raftman.
 3. Host rejected to cockpit by assessment (light, radio, etc.).
 4. Host rejected by personnel.
- The sum of the above determinations

consists of the refrigeration "load" if no moisture is removed from the supply air. Note that items (3) and (4) are influenced by the outdoor temperature shown. Fig. 2 shows the load as a function of outdoor air temperature for a fabric structure.

If it is desired to reduce odour intensity by moisture removal, the heat of evaporation of the separated water

is added to the load. As Fig. 1 shows, a very rapid increase in load can result. This method of calculating load differs slightly from commercial practice, but is convenient in dealing with the code engine.

Much has been said about "environmental" legislation, and controversy

nager as to just what is a comfortable or desirable condition. The airplane designer should study the literature in this field before selecting a cockpit air temperature, mass humidity, or circulation, and radiation exposures all are involved. The advantages of adequate insulation increases when the influence of wall temperatures on comfort is appreciated.

Once an air conditioning refrigeration load has been established by the airplane designer, the equipment engineer can provide devices to do the job, for the number of possible air cycle systems seems to be limited only by the ingenuity of inventors.

Source: *Author's calculations*.

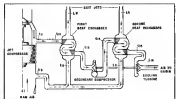


Fig. 2. Fueling system has two fuel nozzles, both dependent on air for ambient flow. Fresh nozzles always bleed air from its venting, opposing effective ambient temperature, and power from fuel line drives compressor between nozzles. This compressor increased pressure along entire tubing, resulting in lower discharge temperature than is simply open. This, though, is unavailability of substance of air to ambient space.

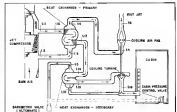


Fig. 4. Representative system has two heat exchangers, but does not depend on room for cooling air flow. It is essentially simple system in which portion of exhaust discharges air is used for cool air entering turbine—below "effective" ambient temperature. It would be used when discharges temperature of a simple system are too high for practical cooling.

PRACTICAL ENGINEERING OF ROTARY WING AIRCRAFT

PART III

By JOHN E. McDONALD, *Engineering Staff, Aetna Company of America*

Outlining all his recent contributions to this authoritative series, Engineer McDonald explains variable speed ranges and damping requirements, then gives a simple solution of a gross vibration problem.

As shown in our preceding installment, two variable speed ranges are encountered in the case of the two-bladed rotor. Lower instability ranges lie between the two critical speeds as defined by Eq. 24. Range covering above critical speed can best be determined from a plot of ω_c^2 vs Ω^2 as shown in Fig. 11, where the limits of stable operation are denoted by points A and B. Eq. 26 defines the unstable speed ranges.

Speed at which instability occurs is sensitive to magnitudes of the term $\omega_n^2/(M + m)$, and shows a progressive increase as the blade mass ratio increases. At $m/(M + m) = 0.5$ the stable region extends to infinity and an upper range of rotor instability exists.

Two-blade rotor exhibits a single range of instability occurring above the critical speed. The range is again completely determined by a plot of ω_c^2 vs Ω^2 . In Fig. 12, points A and B denote the speed limits of stable operation. The frequency equation (17), for $n=2$, of a two-blade rotor, defines the unstable range.

Mid-point of the unstable speed range can be easily determined for the two-blade rotor ($n=2$). At the speed Ω_c^2 , corresponding to the unstable range mid-point, frequency of rotor oscillation equals natural gyrate frequency, and frequency of blade oscillation in the rotating system is equal to natural pendular frequency of a blade turning at the speed Ω_c^2 .

From Eq. 18 (Part VI, Dec. 1946 Aviation), $\omega_n = \sqrt{(M+m)/I_p} \times \omega_n^2$, and

$\omega_c = \sqrt{(M+m)/I_p} \times \omega_c^2$. And since, at the speed operating point $(\omega_c^2/\Omega_c^2) = (\omega_n^2/\Omega_c^2) = 1$, the relationship is written:

$$(1 - \Omega_c^2/\omega_n^2) = \Omega_c^2/\omega_n^2 \quad (26)$$

From Eq. 25 a direct determination may be made to locate the middle of the unstable speed range.

Instability region for a bladed rotor can be eradicated by provision of sufficient "positive" damping in the rotating part and blade hinges. If the frequency Eq. 17 and 26, modified to include the effect of damping terms, are

plotted for higher damping values, it will be found that the gap between curve branches 1 and 2 is eliminated (Fig. 13). Specifically, the complex roots of the frequency equations cease to exist when sufficient damping is introduced.

Approximate damping magnitudes required for suppression of instability can be determined as follows:

1. Determine from undamped equation, the velocity speed Ω_c corresponding to the mid-point of the unstable range.

2. Substitute in the "real" damped frequency equation, value $\Omega_c^2 = \Omega_c^2$.

3. Determine by trial, minimum value of damping parameter λ , which yields real values of ω_c^2 . This task is simplified by assuming a real value of ω_c^2 , equal to $(\Omega_c^2 - 1)$ and finding constant values for λ .

"Real" damped frequency equation for the two-blade rotor becomes:

$$\begin{aligned} & [4(1+\lambda^2)\Omega_c^2 - (2\Omega_c^2 + \omega_n^2 - \Omega_c^2)] \\ & \times [-\frac{m}{M+m}\Omega_c^2 + (2\Omega_c^2 + 1 + \omega_n^2/\Omega_c^2) - \omega_n^2/\Omega_c^2] \\ & + [M + m\Omega_c^2] \\ & \times (2\Omega_c^2 + \omega_n^2/\Omega_c^2 - 1) + M(2\Omega_c^2 - \omega_n^2/\Omega_c^2) = 0 \end{aligned}$$

24 $\lambda_1(\omega_n^2/\Omega_c^2) - (\omega_n^2/\Omega_c^2 + 1) = 0$ (26a)

"Real" damped frequency equation for the three (multi) blade rotor is written:

$$\begin{aligned} & [1 - (\Omega_c^2 - \Omega_c^2)] \left[(\omega_n^2/\Omega_c^2) + \frac{1}{2}\Omega_c^2 - \right. \\ & \left. (\omega_n^2/\Omega_c^2) - \frac{m}{2(M+m)\Omega_c^2} \right] \\ & \times \omega_c^2 (\omega_c^2 - \Omega_c^2) \times 2 = 0 \end{aligned}$$

Since damping parameters λ , λ_1 are related to the damping coefficients by the equations:

$$\begin{aligned} \lambda &= \frac{b}{M + m} \times \frac{1}{\Omega_c} \\ \lambda_1 &= \frac{b_1}{m} \times \frac{1}{\Omega_c} \end{aligned}$$

determination of the velocity damping coefficients b and b_1 is routine. Those familiar with problems of vibration will notice that λ corresponds to twice the fraction of critical damping evaluated by conventional definition of frequency ω_n .

Most often, damping means provided in the slipping gear or at the blade hinge is of the dry friction or hydraulic type, and easily would the damper characteristics approximate those of the linear velocity type. Simplest method of establishing required requirements for friction damping or hydraulic damping is to equate energy dissipation existing in the several types.

If the primary concern is with blade hinge damping, equivalent energy dissipation may be written:

$$W_f = \pi \times b_1 \times \omega_n^2 \quad (26)$$

$$W_f = 4 \times \pi \times b_1 \times \omega_n^2 \quad (27)$$

$$W_h = \frac{1}{2} \times K \times \omega_n^2 \quad (28)$$

(damped by hydraulic damper having characteristic, torque = $K \times \omega_n \times \omega_n^2$)

In the foregoing, ω_n is the frequency of blade oscillation at positive speed corresponding to mid-point of the unstable range ($\omega_n = \Omega_c - \omega_n$). The symbol b_1 represents a purely arbitrary value of angular blade displacement.

In connection with the determination of equivalent friction damping b_1 , should be assumed to be the most extreme in amount of blade displacement which might be induced by a violent landing shock or other disturbance. (b_1 is found to be of the order of 1 or 2 deg in current types.)

Replacing 26 and 27,

$$W_f = \frac{1}{2} \times \pi \times b_1 \times \omega_n^2$$

In determination of equivalent hydraulic damping, b_1 is assumed to be a small blade displacement of such magnitude that very slight drop in placement is associated therewith. Replacing 26 and 28,

$$K = \frac{1}{2} \times \pi \times b_1 \times \omega_n^2$$

Application of Theory

A simple solution of gross vibration problem for rotary wing craft, is as follows: Determine critical speed, center of variable range, and magnitude of blade friction damping required to eliminate instability in a rotorcraft leaving these characteristics—number of blades, n , m , M , blade mass, m , M , m , M , vertical hinge offset, e , in 340 21; distance to blade C.G., R , 1.80 ft; effective link mass, M , 1.80 slugs; blade parameter, $\lambda^2 = 1.429$; natural gyrate frequency, $\omega_n = 4.51$ rad/sec., and stable pendular blade frequency, $\omega_n = 0$ rad/sec.

Magnitude of the parameter λ may

Critical speed Ω_c^2 is determined by substitution of values in Eq. 25:

$$\begin{aligned} & [0 + \frac{1}{2} \times \frac{m}{M+m} \times \frac{1}{\Omega_c^2}] \times 2 - 1975 = 0 \\ & \frac{1}{2} \times \frac{m}{M+m} \times \frac{1}{\Omega_c^2} = 987.5 \\ & \frac{1}{2} \times \frac{1}{1.80 \times 1.80} \times \frac{1}{\Omega_c^2} = 987.5 \\ & \frac{1}{\Omega_c^2} = 3543 \\ & \Omega_c^2 = 1818 \end{aligned}$$

Ω_c value = $\sqrt{1818} = 42.6 \times 4.30 = 183$ rad/sec.

Center of unstable speed range is found by substiting Eq. 25:

$$\begin{aligned} & 1 - \Omega_c^2/\omega_n^2 - (1/\Omega_c^2) \times \frac{1}{2} \times \frac{m}{M+m} \times \frac{1}{\Omega_c^2} + 3 \\ & - 1.2 \times \Omega_c^2 + \Omega_c^2/\omega_n^2 = 354 \times \Omega_c^2 \\ & \Omega_c^2/\omega_n^2 + 3(1 - \Omega_c^2/\omega_n^2) + 1 = 3 \\ & \Omega_c^2/\omega_n^2 = \frac{1}{2} \times \frac{m}{M+m} \times \frac{1}{\Omega_c^2} \times 2 \times \sqrt{3} = 3.732 \end{aligned}$$

$\Omega_c = 1.31$ (The larger value only has equilibrium, no angular motion value is dropped)

$$\Omega_c/\omega_n \times \omega_n = 1.31 \times 4.51 = 5.93$$

First step in determination of blade-damping requirements is the numerical solution of Eq. 17a for the value Ω_c . As an aid to solution, substitutions may be made as follows:

$$\Omega_c^2/\omega_n^2 = 1.21$$

$$\Omega_c^2/\omega_n^2 = (1.31 - 1) = 0.31$$

$$\Omega_c/\omega_n = 1.1$$

$$\Omega_c/\omega_n = \frac{1}{2} \times \frac{m}{M+m} \times \frac{1}{\Omega_c^2} \times \frac{1}{\Omega_c^2}$$

$$0 - 354 \times \frac{1}{2} \times \frac{m}{M+m} \times \frac{1}{\Omega_c^2} \times \frac{1}{\Omega_c^2}$$

$$\lambda_1 \times \omega_n = 4.51$$

Magnitude of the parameter λ may

be established from known characteristics of the slipping gear, but most designers prefer to estimate the value λ , generally, is found to be twice the "fraction of critical damping" indicated by the chart moving as its parts. Experiments will show that once a properly damped gear will demonstrate (or prevent) of critical damping. Employing this fact as a conservative starting point, we may establish the value:

$$\begin{aligned} \lambda &= 20 \\ \text{Since } \lambda_1 &= 2 \times \lambda \\ \text{Since } \lambda_1 &= \lambda_1 \times \omega_n \\ \lambda_1 &= 2 \times 20 \times 4.51 \times (3.732) \times 1.05 \times 4.51 \\ \lambda_1 &= 1,020 \end{aligned}$$

In the determination of equivalent friction damping from the formula:

$$W_f = \frac{1}{2} \times \pi \times b_1 \times \omega_n^2$$

we must substitute the value:

$$\omega_n = \Omega_c - \omega_n = 0.65 - 4.51 = 1.52$$

$$\text{rad/sec., and replace as arbitrary value for } b_1. \text{ (We shall use a value } b_1 = 2 \text{ deg} = 0.035 \text{ rad.)}$$

$$W_f = \frac{1}{2} \times \pi \times 2 \times 0.035 \times 1.52 \times \frac{1}{1.31^2}$$

$$W_f = 308 \text{ ft-lb}$$

Actual magnitude of friction damping equipped as the rotorcraft possessing the specified characteristics was a conservative 600 ft-lb.

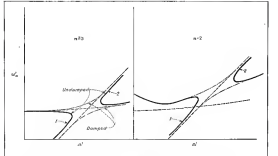


Fig. 13. Effect of damping on rotor instability, two and three (or more) bladed rotors.

PLANT PRACTICE HIGHLIGHTS

Use Special Bar Attachment To Grasp-Move Heavy Racks

•This special steel bar with sliding engagement eye has been devised by Ryan Incorporated Co. for quickly moving heavy storage equipment between plant locations.

To cope with changes in production requirements necessitating movement of storage racks, parts bins, and other facilities, bar is placed over equipment to be moved and is quickly removed. Then back from traveling overhead crane is engaged to bar sliding eye and entire structure is quickly lifted, moved, and placed in new location. Using this device, production needs are met without delay, and flexible assembly line is maintained.



Kit of equipment

A sophisticated method of stably balancing propellers in a test center position has now been developed by Statens Mty. Co., of Dayton, Ohio, which calls only for a suspension point—over a workbench if necessary—and a portable kit of equipment. Its principle is shown in the cross section drawing, Fig. 1.

The portable kit includes front and rear cone adapters for 18, 20, 38, 40, 50, and 58-spline hubs; suspension shaft and axle assembly; top and bottom ends, spacers and wrench.

In operation the propeller is removed from the plane, then front cone, wing ring, and retaining nut are disassembled. Next, electric or hydraulic

power units are inserted and the hub motor thoroughly cleaned.

Then proper adapters are attached to assemble the balancing unit (see Fig. 2). Proper suspension point can be determined for different propellers, as shown in the accompanying table.

Now the unit is suspended from a chain hoist or crane. If the prop is out of balance, the free testing disk over the vertical center line of the shaft will not be concentric with the ring just below it (see Fig. 3). Temporary weight must then be added to the opposite side until the ring is completely concentric by the shaft, as shown in Fig. 4, when the weight can be calculated and added, as necessary, to blade or blades.

Location of Suspension Point From Adapter Core	
Propeller	Distance (in.)
18-spline	0
20-spline	1/8
38-spline	1/4
40-spline	3/8
50-spline	1/2
58-spline	3/4
60-spline	1
62-spline	1 1/4
64-spline	1 1/2
66-spline	1 3/4
68-spline	2
70-spline	2 1/4
72-spline	2 1/2
74-spline	2 3/4
76-spline	3
78-spline	3 1/4
80-spline	3 1/2
82-spline	3 3/4
84-spline	4
86-spline	4 1/4
88-spline	4 1/2
90-spline	4 3/4
92-spline	5
94-spline	5 1/4
96-spline	5 1/2
98-spline	5 3/4
100-spline	6



Automatic Conveyor Speeds Welding Process

•This automatic conveyor, designed and built at Ryan for use with atomic hydrogen welding torch, expedites fabrication of straight stainless steel sections.

The welding process, offering many advantages for use with automatic-on-demand stainless steel, is clean and fast. And it adds no carbon to the welded metal—a feature which is important in manufacture of high-temperature metallurgical systems, because added carbon may reduce corrosion resistance of the steel. Welding time is also a critical factor, because carbon penetrates out of the stainless steel at temperatures from 800 to 1,200 deg. F. Within this temperature band, the carbon may form harmful chromium oxides which open paths for intergranular corrosion. Hence, welding heat should be applied for minimum possible time to leave the steel furnace unaffected.

With the automatic conveyor Ryan welds can step up the speed welding of salient stainless sections to 36 in. per min. Smooth, strong welds are obtained, and the parent metal retains original ductility.

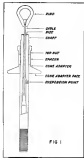


FIG. 1

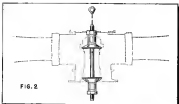


FIG. 2



FIG. 3



FIG. 4

GRUMMAN'S NEW MALLARD
HAS NOVEL REFINEMENTS

Concluding this study, details are presented concerning cabin features, auxiliary step, integral fuel tanks, and engine mounting.

PART II



Fig. 6. Half-painted finished painting in Mallard cabin effectively complements shell upholstery.

UNDERSTANDING OF THE Mallard is effectively highlighted by examining panels of Finewood-Ming-U. S. Plywood products. This paneling (Fig. 5), consisting of 1/8-in. low wood veneer sheeting bonded to a fabric backing for flexibility, is attached to the metal interior with Goodyear Plastbond—synthetic rubber cement—then waxed and polished.

Spots between walls and baggage compartment at landing rest is completed by Finewood-Ming-U. S. Plywood products. This paneling is attached to the metal interior with Goodyear Plastbond—synthetic rubber cement—then waxed and polished.

Auxiliary Step

To eliminate overloading in slow-speed water testing, small auxiliary steps (Fig. 6) are located just ahead of and under wing on both sides. These auxiliary steps provide straight-ahead flow pattern, thus eliminating irregular flow actually encountered around round steps.

Integral Fuel Tanks

Fuel is stored in the wing center section box beam assembly (Fig. 7). Each integral tank has 175-gal. capacity and



Fig. 7. Box beam has small auxiliary step (shown in cross-section) to provide straight flow just ahead step.

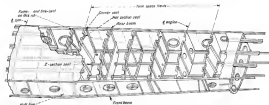


Fig. 7. Detail of center wing section box beam assembly used for fuel storage.

is delineated by rib members, front and rear beams, and upper and lower skins. Three access holes in front beam and two in rear beam are of 15-in. dia. Square Wadco welds (100% inspection of flaked, carbon black, and other ingredients in metal/skin interface) seal all inner surfaces of the tank with a rubber like film. With this installation, area between stringers and stiffeners (not sealed with tape type seal or rigid tank) is used for fuel storage. Rib adjacent to hull side of tank is provided with frame and low seal, so that wing leakage past ribbed end of tank space is trapped and drained overhead instead of into cabin.

Air fill of each wing tip float, also treated with Klean-Seal, is sealed, providing additional fuel storage space (optional feature).

Wing tank fuel is utilized first, then fuel from float tank is pumped into wing tank. If auxiliary float pump which services the float tank is turned on when wing tank cannot accommodate more fuel, fuel supply will be vented overhead.

Engine Mounting

Each power plant, its accessories, cowling, and control equipment is quick change unit removable from the firewall, materially reducing engine change time.

Engine is rigidly bolted to engine mount ring, which in turn is rubber shock mounted to fuselage (Fig. 8). This arrangement allows for integral deflection of engine and ring, as a unit, and tends to eliminate former vibratory deflection between these installations. Accordingly, attachment of these accessories which are hung from the ring and joined to the engine, is greatly simplified, since need for mounting accessories on ring with flexible connections is then obviated.



Fig. 8. All upper left is one of four rubber shock mounts between mount ring and fuselage. Engine is rigidly mounted to ring to provide integral deflection of these installations.

FLYING EQUIPMENT

Home-Made Roadable Readied by L.A. Inventors

Whitaker and Zuck display ingenuity in two-seater
Plane-Mobile built in their spare time at low cost.

WGA "Aerobus" Photo by John H. Jones

Development of a major personal roadable plane is underway in Los Angeles with completion of a prototype embodying several interesting features including variable wing-folding wings, retractable tail fins, and use of two control pedals. A "Skycruiser" project, the craft, named the Plane-Mobile, has been previously featured here by its partner designer-builder, Stanley D. Whitaker, 4840 Valley Ridge, Los Angeles, and Donald D. Zuck, 3122 W. Adams Blvd., with production and assembly being done by Diversions in their spare time. Now ready for flight testing, the craft is said to represent an investment of less than \$500 in raw and salvaged materials in addition to about 15,000 man-hours of total labor expended.

Data are given as follows: Span 31 ft. 6 in., overall length 33 ft. 6 in., height 8 ft. 9 in.,

wingless 8 ft. 5 in., trend 5 ft., wing area 213.54 sq. ft., aspect ratio 8.75, wing loading 9.87 lb./sq. ft., horizontal stabilizer loading 3.45 lb./sq. ft., maximum speed 40-50 mph., weight empty 760 lb., and gross weight 1,150 lb. Dimensions with folded wings are: overall length 24 ft. 11 in., overall height 6 ft. 4 in., and overall width 6 ft. 11 in.

Whitaker and Zuck planned the Plane-Mobile around the most favorable mobility characteristics possible, even though it meant incorporating several compromises upon aerodynamic design.

An independently sprung three-wheel landing gear has been devised, with the front wheels steerable and cable-linked to the main wheel, and the rear wheel taking the transmission for driving on the ground. For good road stability the designers have loca-

ted the wheels as far from the craft's G.O. as possible—forward gear being positioned well forward of the wing leading edge. And in order to maintain the characteristic without interfering flight qualities, it was deemed necessary to incorporate a variable incidence wing.

This embody a "swing wing" structure in which right and left wings are linked to the fuselage by means of bearings and are free to pivot about the center of lift axis. Each gear-wing has been equipped with an "Aerobus" and each directly an "Aerobus" (airborne elevator). This is a system linked to the control wheel to enhance the wing's angle of attack—mainly for climb and descent, and differentially for turning.

Instead of conventional wing-mounted flaps, the Plane-Mobile is fitted with opposite-acting split flap devices, con-



Whitaker (left) shows left wing while Co-Designer Zuck features its moved head and connected to fuselage just above main window. At right, split wing rest, still as forward supporting strut, will show wing carrying boom and attached to main fuselage.

prising the rear portion of the horizontal stabilizer. This meaning is said to eliminate possible moment evenly common to wing flaps.

Another of the craft's interesting features appears wing's folding and support system. Clearly detachable lightweight steel frames are positioned ahead of the cabin and also upon the vertical stabilizers. Each wing section is hinged from an supporting light strut, and can be swung back over the fuselage to rest upon the forward and rear carrying frames and are then locked upon them as an overlapping platform. The wing struts are stored beneath the overhanging wings.

Gears were adopted to deal control wheel movements into elevator cable connections at the wing roots, also star gears actuating from control gears on the wings and folded back. Elevator and control wheel cables thus maintain their designed tension, and are said that an adjustment is required for turning the planes for flight when there is a check to see that control wheel and elevator gears are properly meshed.

Said to be added to the present craft is a hydraulic motor (already built and ready for assembly) for ground propulsion, also a clutch for disengaging the propeller when the Plane-Mobile takes to the highway. The Continental engine will supply with a hydraulic pump carrying planetary connection to a small hydraulic motor mounted just above the rear wheel and using a chain drive transmission. A four-way valve in the pump system drives.

While the design firm of the present

Plane-Mobile effort to the careful maintenance of the facilities, they have already placed a device various with several refinements over the trial craft.

The future model will be designed to have the cabin in the forward section of a landing-shaped fuselage, ahead of a barrel engine that will have two power transmission shafts—one to the rear wheel and one to a pump prop, mounted behind the control fin.

As laid out now, a modified Ryan-6-200 of 135 hp at sea level would

be fitted, giving the craft a sea level top speed of 150 mph., 250 mph. cruising speed, 40-mph. maximum speed at 1,400 ft. gross weight (empty about 750 lb., wing loading 11.58 lb./sq. ft., gross loading 11.58 lb./sq. ft., and service ceiling 16,500 ft. Speed is placed at 30 ft. 6 in., height 6 ft. 2 ft. 3 in., length 32 ft. 6 in., and wing area 213.54 sq. ft. Landing gear would be fully retractable.



Actual reception of latest Plane-Mobile showing many design improvements such as stream line retractable landing gear, and power prop. Craft reported landing (top) without major or minor delay in horizontal stabilizer. Similar modifications is said as typical prototype.



Prototype Plane-Mobile snapped during test flight. Will Co-Designer Stanley D. Whitaker at controls. Left wings are closed here to good

effect. Powered by a 45-hp. Continental engine actuated from a Power Coil, unit is said to have a gross weight of 1,150 lb.



Cutaway sketch of Fiat G-12 displays cable pulleys, fuel containers, main air pressure for strong supports and more. Wings are of rubber for rapid retracts. Powered by three Fiat P-10s. Wings, fuselage and tail are of aluminum alloy. Speed is 311 mph.

Fiat Transport Marks Italian Comeback



Overhead and side views of Fiat G-12, showing 25-40 seating arrangement.

Large all-metal biplane, built with Allied supplies, is stated to be medium-range high performance craft utilizing American or domestic power plants.

A contract to provision of the plane treaty concluded by the Allies with Italy, that country is permitted to engage in commercial, military and military aviation activities. Italian planes are that little time is being lost in taking advantage of this situation, and a large new aircraft, the Fiat G-12, has already been produced.

Varied seating arrangements from 25 to 40 have been considered for this all-metal low-wing tractor monoplane, powered by 1,400-hp. Fiat D-1200 or 1,600-hp. Alfa Romeo 1200 cc engine turning three-blade full-dish-wing propeller. Fitted with 12.5% and carrying 30 passengers, the G-12's top speed is scheduled to be 311 mph at 6,000 ft. Other data include a 35,000-lb. gross weight, 25,000-lb. empty weight,

normal range of 2,500 mi., and a maximum range, with 1,350 gal. of fuel, of 1,800 mi. Ceiling is given as 35,000 ft., while the craft is designed to maintain flight at 15,000 ft. with one engine and a crew of four is to be carried.

Features of distinctive monospace fuselage, low flat bottom and sides and oval-shaped roof. Wings are of aluminum alloy. With wings at rather far back, and with the feature of a biplane wing loading, the plane is afforded a high degree of stability. All landing wheels are hydraulically retractable, though a small portion of the main wheel remains exposed.

Span is 90 ft. 4 in., length 76 ft. 6 in., height 13 ft. 6 in., propeller dia. 11 ft. 6 in., wing area 1,100 sq. ft., and dihedral of outer wing panels 6 deg.

INDUSTRY-WIDE BARGAINING...

Death Trap for Business, Suicide for Free Labor

IF CONGRESS is to succeed in its present efforts to prevent strikes in key industries from devastating the nation, it will have to put a crimp in industry-wide collective bargaining. This kind of bargaining is designed to apply agreements between employers and organized workers on wages and working conditions to an entire industry.

Further, if extension of this type of bargaining is not curbed, there is reason to believe that it will undermine the freedom of both American business enterprise and American wage earners. For, while increasing the destructive power of labor disputes, the general spread of industry-wide bargaining would so concentrate the fixing of wages—by far the largest element in the cost of production—that government regulation would be a next short step. With that step taken, freedom for business enterprise and freedom for labor would be well on the way out.

Unfortunately, industry-wide bargaining is commonly regarded as presenting a general conflict between organized labor and employers, with unions favoring itself and employers opposed to it. This mistaken notion raises the heat of much of the discussion without increasing the light. The fact is there is no such general conflict. Employers and organized workers are on both sides of the argument about industry-wide collective bargaining. For example, while some union leaders are characterizing as labor leaders all those who enter the slightest question as to the desirability of industry-wide bargaining, organized workers in the air transport industry are strenuously opposing that type of bargaining; and the employers are advocating it.

Some Employers Like It

The reason there is in fact no clear cut issue between employers and unions over industry-wide bargaining is readily understandable. It presents certain advantages to both sides in the bargaining process. For example, union advocates of such bargaining generally stress the fact that industry-wide agree-

ment on wages protects wage standards from being undercut by lower wage areas and lower wage employers. By much the same token, however, employers who like it often emphasize the fact that industry-wide bargaining may save certain well-managed and prosperous companies from being singled out for particularly heavy wage exactions. This general point has been underlined in both the full-dish-wing industry and the West Coast paper and pulp industry. There, local unions, affiliated with international unions, have protested that industry-wide collective bargaining prevents them from getting from especially prosperous employers wages as high as they could get if allowed to go it alone in collective bargaining.

So long as employers remain subject to the federal antitrust laws while unions are exempted, the balance of power in industry-wide bargaining would seem to be heavily weighted on the side of the unions. If, for example, employers were to announce an intention to match an industry-wide wage increase by an industry-wide price increase, there is no doubt that they would promptly be indicted for violation of the federal antitrust laws. Even so, the fact remains that some employers favor industry-wide bargaining while some segments of organized labor are against it.

A Clear Cut Public Issue

The industry-wide bargaining issue as it affects the public, however, is clear cut. It is concentration of economic power (in the hands of both unions and management) which can make industrial conflict devastating to the public welfare. At least five times within about a year—in steel, on the railroads, in the maritime industry and twice in the soft coal industry—strikes prompted by union efforts to impose industry-wide agreement about wages and working conditions have paralyzed large parts of the nation's economic life.

In soft coal about 90% of the production workers are members of the United Mine Workers. In steel

about 80% of the production workers are members of the United Steelworkers, C. I. O. In some other key industries there is a comparable degree of concentration of union control. In the face of such concentration many employees see no alternative but to get together on their side for industry-wide bargaining. But when they do so in key industries, the odds are lengthened that failure to agree on wages and related matters, will result in generally ruinous conflict. If agreement is reached, the chances are increased that it will take too little account of the welfare of the consuming public.

It is possible to have industry-wide bargaining on many subjects other than wages. But the main interest is wages, and the main drive is toward industry-wide and ultimately nation-wide uniformity. Such uniformity is the deadly enemy of industrial decentralization and the pioneering expansion of industry in new areas. Why, please, with inexperienced workers, if the wage rate must be uniform for the whole industry? Moreover, it would also be hard to conceive of a more effective way to put a blight on local efforts to improve industrial relations than to make wage rates and other working conditions uniform throughout the industry and then the nation. However, among every other danger, the overwhelming danger in industry-wide bargaining lies in its concentration of economic power.

Wages Monopolized

On the average, the cost of labor accounts for about two-thirds of the total cost of all industrial products. The universal spread of industry-wide bargaining would thus concentrate in relatively few hands control of the greater part of the cost of industrial production. There is no reason to believe that even without disastrous strikes, such concentration would long continue free from government regulation. That would turn more earth for the graves of American business enterprise and American working men's freedom.

Those who believe that industry-wide bargaining serves the public well—and many strong people do—stress the fact that, on the whole, it has worked in the industries where it has been tried over a considerable period. Most of the industries of which this is true, however, are not key industries. The pottery industry, the glassware industry, and the silk and rayon dyeing industry—to cite a few in which industry-wide bargaining has been practiced with considerable success—are important industries. But they are not industries in which strikes would have a ruinous impact on the nation. In contrast, a strike in the soft-

coal industry as the result of a breakdown of industry-wide negotiation quickly becomes a national disaster. The dangers inherent in industry-wide bargaining are multiplied accordingly.

England No Guide

Those who think extension of industry-wide bargaining would be good for the public often emphasize the fact that it has worked smoothly in England, where it has been extensively practiced. Not the least of the things it has smoothed in England, however, is the transfer from private enterprise to state socialism of industries in which industry-wide bargaining by monopolistic unions and employer groups had so badly undercut competition that private enterprise had lost much of its justification. A general extension of industry-wide bargaining could be expected to have the same consequences in this country.

The best way to curb industry-wide bargaining is a question which lies beyond this discussion. Much would be accomplished if the federal government would discontinue its active promotion of industry-wide adjustments, in the fields of both labor and management, at which it has been busy ever since N. R. A. days. Still more would be accomplished if the federal antitrust laws were applied with even-handed justice both to unions and employers—a course urged in the 32nd editorial in this series. Perhaps a definite limitation of the scope of labor agreements would also be necessary.

The effects of industry-wide bargaining in increasing the extent of public regulation of industry will vary. They will, of course, be less pronounced in railroads and other public utilities, which are already extensively regulated, than they will be elsewhere. For unregulated industries, however, industry-wide bargaining carries the threat of extensive regulation and, along the way, of industrial conflict devastating to the public. In these excited times, to say what I have said here is to invite characterization by over-heated partisans as a foe of legitimate union progress. That is perhaps not so bad, however, as to qualify as a pull trigger for both American business enterprise and some of the basic freedoms of American working men. That may well be the fate of those who blindly accept the expansion of industry-wide collective bargaining as being "in tune with the times."

James H. McGraw, Jr.

President McGraw-Hill Publishing Company, Inc.



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SHEET NUMBER	8-28 (Part II)
CLASSIFICATION	Processes
SUB CLASSIFICATION	Temperature Equivalents

Centigrade-Fahrenheit Conversions

Interpolation: 1 deg. C. equivalent to 2 deg. F.; 2/5, 3/5, 4/5, 5/5, 6/5, 7/5, 8/5, 9/5

°C	9	10	20	30	40	50	60	70	80	90
-200	-230	-248	-284	-302	-340	-358	-404	-424	-460	-478
-180	-248	-266	-302	-320	-358	-376	-424	-442	-478	-496
-160	-266	-284	-320	-338	-376	-394	-442	-460	-496	-514
-140	-284	-302	-338	-356	-394	-412	-460	-478	-514	-532
-120	-302	-320	-356	-374	-412	-430	-478	-496	-532	-550
-100	-320	-338	-374	-392	-430	-448	-496	-514	-550	-568
-80	-338	-356	-392	-410	-448	-466	-514	-532	-568	-586
-60	-356	-374	-410	-428	-466	-484	-532	-550	-586	-604
-40	-374	-392	-428	-446	-484	-502	-550	-568	-604	-622
-20	-392	-410	-446	-464	-502	-520	-568	-586	-622	-640
0	-410	-428	-464	-482	-520	-538	-586	-604	-640	-658
20	-428	-446	-482	-500	-538	-556	-604	-622	-658	-676
40	-446	-464	-500	-518	-556	-574	-622	-640	-676	-694
60	-464	-482	-518	-536	-574	-592	-640	-658	-694	-712
80	-482	-500	-536	-554	-592	-610	-658	-676	-712	-730
100	-500	-518	-554	-572	-610	-628	-676	-694	-730	-748
120	-518	-536	-572	-590	-628	-646	-694	-712	-748	-766
140	-536	-554	-590	-608	-646	-664	-712	-730	-766	-784
160	-554	-572	-608	-626	-664	-682	-730	-748	-784	-802
180	-572	-590	-626	-644	-682	-700	-748	-766	-802	-820
200	-590	-608	-644	-662	-700	-718	-766	-784	-820	-838
220	-608	-626	-662	-680	-718	-736	-784	-802	-838	-856
240	-626	-644	-680	-698	-736	-754	-802	-820	-856	-874
260	-644	-662	-698	-716	-754	-772	-820	-838	-874	-892
280	-662	-680	-716	-734	-772	-790	-838	-856	-892	-910
300	-680	-698	-734	-752	-790	-808	-856	-874	-910	-928
320	-698	-716	-752	-770	-808	-826	-874	-892	-928	-946
340	-716	-734	-770	-788	-826	-844	-892	-910	-946	-964
360	-734	-752	-788	-806	-844	-862	-910	-928	-964	-982
380	-752	-770	-806	-824	-862	-880	-928	-946	-982	-1000
400	-770	-788	-824	-842	-880	-898	-946	-964	-1000	-1018
420	-788	-806	-842	-860	-898	-916	-964	-982	-1018	-1036
440	-806	-824	-860	-878	-916	-934	-982	-1000	-1036	-1054
460	-824	-842	-878	-896	-934	-952	-1000	-1018	-1054	-1072
480	-842	-860	-896	-914	-952	-970	-1018	-1036	-1072	-1090
500	-860	-878	-914	-932	-970	-988	-1036	-1054	-1090	-1108
520	-878	-896	-932	-950	-988	-1006	-1054	-1072	-1108	-1126
540	-896	-914	-950	-968	-1006	-1024	-1072	-1090	-1126	-1144
560	-914	-932	-968	-986	-1024	-1042	-1090	-1108	-1144	-1162
580	-932	-950	-986	-1004	-1042	-1060	-1108	-1126	-1162	-1180
600	-950	-968	-1004	-1022	-1060	-1078	-1126	-1144	-1180	-1198
620	-968	-986	-1022	-1040	-1078	-1096	-1144	-1162	-1198	-1216
640	-986	-1004	-1040	-1058	-1096	-1114	-1162	-1180	-1216	-1234
660	-1004	-1022	-1058	-1076	-1114	-1132	-1180	-1198	-1234	-1252
680	-1022	-1040	-1076	-1094	-1132	-1150	-1198	-1216	-1252	-1270
700	-1040	-1058	-1094	-1112	-1150	-1168	-1216	-1234	-1270	-1288
720	-1058	-1076	-1112	-1130	-1168	-1186	-1234	-1252	-1288	-1306
740	-1076	-1094	-1130	-1148	-1186	-1204	-1252	-1270	-1306	-1324
760	-1094	-1112	-1148	-1166	-1204	-1222	-1270	-1288	-1324	-1342
780	-1112	-1130	-1166	-1184	-1222	-1240	-1288	-1306	-1342	-1360
800	-1130	-1148	-1184	-1202	-1240	-1258	-1306	-1324	-1360	-1378
820	-1148	-1166	-1202	-1220	-1258	-1276	-1324	-1342	-1378	-1396
840	-1166	-1184	-1220	-1238	-1276	-1294	-1342	-1360	-1396	-1414
860	-1184	-1202	-1238	-1256	-1294	-1312	-1360	-1378	-1414	-1432
880	-1202	-1220	-1256	-1274	-1312	-1330	-1378	-1396	-1432	-1450
900	-1220	-1238	-1274	-1292	-1330	-1348	-1396	-1414	-1450	-1468
920	-1238	-1256	-1292	-1310	-1348	-1366	-1414	-1432	-1468	-1486
940	-1256	-1274	-1310	-1328	-1366	-1384	-1432	-1450	-1486	-1504
960	-1274	-1292	-1328	-1346	-1384	-1402	-1450	-1468	-1504	-1522
980	-1292	-1310	-1346	-1364	-1402	-1420	-1468	-1486	-1522	-1540
1000	-1310	-1328	-1364	-1382	-1420	-1438	-1486	-1504	-1540	-1558

°F = °C x 9/5 + 32 Absolute Zero = -273.1°C

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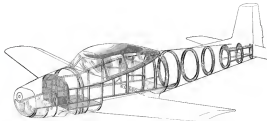
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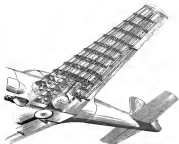


North American Navion

Perspective view showing semi-monocoque construction of fuselage part of fuselage. Two upper longerons are formed from bent-up U channels extending from firewall and

curing to join at left end of fuselage enclosure. All section of fuselage is formed by bulkhead rings covered by three sheets of 245T Alclad.

Cutaway drawing showing construction of Navion wing, which consists of right and left hand panels bolted together at a center rib beneath fuselage. No full span front spar is used, shear loads being carried by rear spar and leading edge. Construction rear spar and lower skin is made of bent-up 2024 and 2025 345T Alclad sheet reinforced by stiffeners and spars. Two short spars extend from leading gear rib and as reinforcing members, one of which, with a shorter beam supports main landing gear retracting mechanism. Airfoil is NACA 4415R at root, NACA 6410R at tip; rear chord is 7 ft. 3 in. (19/32 in.), tip chord 3 ft. 11 in., total area is 10 sq. ft. 4 7/8 in., with total area of 184.34 sq. ft. including ailerons, flaps, and 19.89 sq. ft. covered by ailerons.



AVIATION, February, 1947

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various driving strategies at larger average speeds all resulted in degraded fuel economy and degraded for emissions or transport loads.



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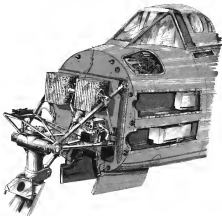
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Illustrating installation of nose landing wheel in model specially modified for high speed flight. Heavy blades attached to landing gear mount are to maintain proper C.G. following removal of moment. Note changes in

cockpit canopy, in which small transparent surfaces are substituted for larger bubble type canopy, which tended to warp due to heat which has been generated at 820 mph, plus speeds.



Messerschmitt Me-163

Unloading and emergency jettisoning mechanism includes: Unloading lever (A) shown in unlatched position, emergency jettisoning lever (B), locking rods (C), slide guide (D), and locking spring (E).

*Global Avigation System
Projected by PICA0*

Techniques and devices which Organzaeflex favors in new designs provide uniform radio-aid facilities, thus improving regularity and safety of world's commercial air transport.

Recommendations for world-wide standardization of radio systems, the table accompanying this article (page 221).

Consequently, an effective environmental focus for civil aviation has been made by the Provisional International Civil Aviation Organization. A modification of the CAA instrument landing system (ILS) is favored for airport landing facilities, a combination of the very high frequency (VHF) radiofrequency and the very low frequency (VLF) radiofrequency modes. It is recommended that the VLF mode be in room mode, and the VHF mode, locally appropriate.

It was recognized that all graduate students should be obtained from the facilities with maximum effort by pilot. The experiment, providing the guidelines, should operate automatically as far as possible. The functions performed by the facilities should be such as to collect the data of power, emissions, loads, loss and heat flow in controlled manner. The experiment was characterized for which he is responsible, and studying how to use his own experience.

The table accompanying this article
(page 83).

Conclusions, on which selection of the many available electronic techniques for air flight guidance was made, included degree of development, readiness of adoption, simplicity of manipulation, and appropriateness of the placement of controls. Numerous techniques in the design stage were considered, but the pressing need for immediately usable equipment forced dismissal of these recommendations.

It was recognized that all guidance functions should be obtained from the functions with maximum effect by the pilot. The equipment, providing the guidance, should operate automatically as far as possible. The functions performed by the functions should be such as to relieve the pilot of purely mechanical tasks, leaving him free to observe the functioning of the aircraft and equipment over which he has control and for which he is responsible, and enable him to exercise his supervisory

judgment in matters of procedure, unencumbered by routine operations. Such freeing of the pilot from operations better performed by automatic equipment, so that he can more fully concentrate on the spot judgment, should result in fewer accidents than the direct employment of the facilities themselves.

The manner in which the equipment operator should not require the support staff to enter into the aircraft handling functions of the pilot—thus leaving the central focus personnel free to concentrate on matters of traffic control performance. The equipment should perform in such manner that it does not "disturb" — *e. g.*, does not have an inherent bias to the number of planes it can serve at any one time. And it should be capable of future development toward automatic operations, also should supply its information in such form that estimates of pilots, and the like, are not controlled by it.

The position of the equipment that must be earned in the place should be light and unobtrusive. However, it should be borne in mind that the space and weight taken by the equipment is more than returned to desirable selection.



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Team	W	L	T	Points
Team 1	11	2	0	22
Team 2	10	3	0	20
Team 3	9	4	0	18



Experimental FAP nondirectional radio range meter. Rather a coarse (1) indicated by setting controls and followed by bearing error meter contained as pointer is found by bearing controls that solid zero position indicates no error.

all-around firing of the transmitter. Most pointing in the position of leading civil air transport aircraft under all conditions of visibility at the fastest possible rate. To provide facilities whereby pilots can maneuver in the leading strip regardless of the ending, the recommendation is for ILS, with start modification. This provides a definite leading path that individual pilots can follow by instrument or even as they are cleared for leading from the control tower, and without further instruction from the traffic personnel. The system also offers the possibility of controlling the stripplot from the ILS tower without modification of the ground installation. Thus ILS offers operational simplicity and possibility of future development toward automatic operations, as well as a solution to the nonstop problem.

Instead of the 90 and 150 cycles per second (cps.) range used on the location of H&S, a 30 cps. signal superimposed on an ultrasonic transmitter will be used. The phase of the 30 cps. will be used to indicate no error. In this way the aircraft receiver can be used automatically for communication and for leading indication. Changeover to the phase-synchronous bearing should begin in 1951, meantime, existing equipment now installed at over 1000 airports will be used as a temporary expedient. To give pilots an indication of distance from the lead-

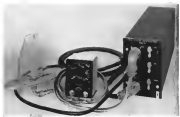
down point, it was recommended that by 1952 two markers should be replaced by distance measuring equipment (DME) using the interrogator-response technique (described in later paragraphs) to give continuous numerical indication of distance to the air-strip.

For short range flights between local fields and along routes of heavy air traffic, there is favored the VHF com-

municational radio range, a system providing an indication of bearing to a local ground station. At the ground transmitters, two stations are created. One carrier has a 50 cps. tone modulated on it by first being imposed by frequency modulation on a 10,000 cps subcarrier, which in turn amplitude modulates the radio frequency carrier operating between 115 and 215 megacycles (mc.). The phase of this 50 cps. tone is the same as all directions from the transmitter. A second 50 cps. tone is directly modulated onto the radio-frequency (R-F) carrier, but it is so modulated that it varies in phase with velocity. Difference in phase between the fixed or reference tone and the variable phase tone is used to operate a zero position indicator in the plane. The pilot sets on azimuth indicator (calibrated from 0 to 360 deg.) on the desired course, then finds that course by holding the zero indicator at zero. Or he can determine his magnetic position relative to the transmitter by rotating the azimuth indicator until the zero position indicates no error.

To avoid ambiguity the scale of the indicator is graduated with green and white sectors, with positive colored counterweights and read with the center of that scale. A red center of the sector scale, or flag shown, indicates loss of signal when the plane flies out of the range of the transmitter. The pilot then selects another station.

To indicate range from the station for which bearing is obtained by the nondirectional range facility, transponder type radar distance measuring equipment is used. The plane carries a pulsed transmitter that reflects the interrogating signal in the 1,300 mc.



DME pulsed distance measuring equipment (above) is to be used with nondirectional type to give distance from leading station. Ultimately, some type of equipment will be employed with improved leading facilities to give distance from runway during approach. Distance is at left range meter is center, and ultrasonic equipment at right.

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AVIATION, February, 1967



Low-frequency laser, operating at a radio frequency low enough to cover large distances without requiring accurately located earth and ground layers in upper atmosphere, provides line for computer by simple adjustment of receiver-transmitter, shown here, for any weather conditions. Receiver on the laser does quickly and accurately with the equipment than by other observation in a clear night.

load. When this pulse reaches the ground station, that station transmits a coded pulse of another frequency. The ground transponder is capable of simultaneously replying to 50 planes. Basic material basis on the transmission of the interrogating pulse from the aircraft and the response at the aircraft of the responder pulse is a function of the distance between plane and ground station. The responder has a range of 120 mi. and an accuracy indicated of 1/15.

At the receiver in the plane, two electrical gears are made to move at the same rate they rotate on the responder pulse. Thus only the correct responder pulse is selected by the gears to the reflecting circuit. Voltage that controls the laser position of their galvanic operates the indicator so that an indication can be calculated directly in range. A lamp associated with the indicator flashes in accordance with the coding of the responder to indicate which ground station is being interrogated. When the plane has set of range of the ground station, the lamp glows continuously. Loss of the signal for short periods up to 50 sec.—as during a bank turn—does not disturb the indication.

Together, the nonradiofrequency radio range and the distance measuring equipment provide the pilot with navigation accuracy and range anywhere within range of a ground station providing the facility. He can thus fly

any route, in fact, in because of the low the antipodal course. The ground station is automatically moved to detect instruments in an indication. The distance measuring position of the equipment, in a suitable indication, forms the basis for the corresponding equipment to be used with ILS to indicate distance from the low-frequency plane.

Low-frequency laser chains are to be installed to provide lines of position for long-range navigation over regions not covered by standard laser chains. It was recommended that FICAO have a group to suggest when for additional standard and new L-F laser stations. Installation of L-F laser stations will begin on North America in 1968 and be extended to other regions of air traffic in 1969. The hyperbolic lines of position provided by the true delay in reception of pulses from L-F laser chains provide a continuous system allowing the aircraft to locate its position in all weather conditions. Although extensive tests have not been made, indications are that the system will

provide coordinates over the polar regions.

Along with L-F laser, the standard hyperbolic system of the opening at a station, and that station range, L-F, will be considered by a special instrument for use in Europe, where existing the chain already under the ground position of the navigation. This would replace the conventional range and DME facilities for short-range navigation over Europe.

Recognizing that in other techniques are proposed it will be desirable to make use of them, FICAO estimated those that appeared most likely to 50 future needs, and it recommended that reference radar be developed in an aircraft to support traffic control. Such a radar system would provide monitoring of the reliability of the ILS beams, give position of aircraft during approach, and provide emergency facilities should other equipment fail. Basically, smooth airport traffic movement requires that all planes carry two-way radarscope for lower navigation.

Frequency Allocation Desired by FICAO

Requests for frequency system frequency bands, compiled now as likely to be needed in future, are to be filed by FICAO member states with International Telecommunications Union, as follows:

VLF channels	112-115 mc
Continuous monitoring equipment	119-121 mc
LF channels	130-132 mc
ILS glide path	124.5-124.6 mc
DME channels	130-132 mc
Short-range DME	130-132 mc
CCA precision radar	130-132 mc (130-132 reserved for navigation)
Navigation radar	130-132 mc (130-132 reserved for navigation)
Standard radar	130-132 mc
L-F laser	130-132 mc



Navigation radar could be used by control tower personnel to (1) locate planes within by range capability, (2) spot planes in traffic, (3) check on position with which planes operate—this includes reliability of position, (4) check on position with which planes operate—this includes reliability of position, (5) check on position with which planes operate—this includes reliability of position.

AVIATION, February, 1967

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Uruguay and Bolivia Facing Civil Aviation Reorganizations

By GEORGE M. GALSTER, *Latin American Analyst*

With their respective governments taking a keener interest in aviation activities, *Aviation* predicts possible changes are slated, aiming for development of broader and more efficient commercial services in these South American republics.

IN THIS presentation, covering both countries, we will first consider Uruguay: Commercial aviation in Uruguay is apparently heading for a period of rapid growth, but its future is obscured by the immediate possibility of complete government ownership. This doesn't imply that the industry must necessarily either undergo such an arrangement, since considerable Uruguay has traditionally been a good manager of the nationalized banks, power companies, insurance organizations, and even its ballet and

theatrical ensembles. However, the development of a state-owned aviation industry, now being discussed, certainly bears close watching.

Essential to use of all the South American countries, Uruguay has comparatively the best ground transportation system on the continent. Air services, like air seaports, have not developed to the degree common in other areas. The first law, approved with British capital in 1936, was called *Proyecto Leyes Uruguayas de Navegacion Aerea*, S.A. (PLUNSA). Operations started with two DH. Dingooff craft, and later the company purchased a Peino and a pair of four-engine D58 Superiors. The company shortly lost money until 1948, when the government granted a subsidy of 124/100 pesos and the Bank of the Republic guaranteed a loan to purchase two Douglas DC-3s. Little improvement was made, however, and operations finally suspended in 1953. The following year, the company was reorganized under the same name, but in a second stage, that is, with the government holding 50% of the stock and private interests the remainder. This is the financial setup at this writing.

The other airline in Uruguay is *Compania Argentina Uruguay*, organized in 1936 by the banker Luis Repetto, and the former foreign minister, Jose Rovinsky. This company was controlled on the initiative *Compania Aeronautica* traffic with two fast, four-engine Ju-52s, which were replaced only last year with four Bessinghams. CAUSA runs a regular schedule with the Argentine *Compania Sudamericana de Servicios Aereos* (CSA) to share the international route on the route, and such company was limited to two round trips daily.

During the war, when Argentina was unable to assure open ports, CAUSA temporarily increased its flight frequency. However, the original agreement has remained in spite of its increased demand for this service. Now that Delors has taken over CSA and merged it with his ALFA line, it is possible that some new arrangements may be worked out.

That, then, is a brief review of



No routes in Uruguay. Montevideo-Punta del Este run is made only during November-December period. CAUSA, CAUSA, and projected routes are shown.

AVIATION, February, 1957

AVIATION, February, 1957

Uruguay's commercial aviation. To its demand that the government has previously taken over control of the industry, it is necessary to go back to Dec 1949, when the exportational national aircraft law was passed by congress. In addition to the already granted PLUNA, the act also appropriated a yearly subsidy of about \$80,000 to CAUSA. The two companies were obliged to accept the government's membership on their board of directors.

CAUSA's operating resources were also limited to six years (expiring this past December), and this point required much negotiation in Montevideo. Last July, the government and that CAUSA's route to Buenos Aires was open to any company that would accept the government to control profits. Such an agreement would also give the government the right to take over all private stock in the company at any time. PLUNA made the only bid for the route operating handicaps, but with elapsed time between offers almost tripled because of the trip to and from airports. Since this would be non-ideal, the government rejected the offer in December keeping to favor CAUSA's bid.

It is rumored that some stockholders would prefer to liquidate the company rather than accept government control, but it is generally expected that CAUSA will eventually agree to this arrangement. Dubois is effectively barred from competing by a new law (introducing a series of airline transport laws to regulate air transport). This was also one reason Dubois' rumored plans to move his international airline to Uruguay never developed.

Coming back to PLUNA, the compensation offered in 1944 also provided a subsidy of \$50,000 in 1948, \$40,000 in '49, \$30,000 in '50, \$20,000 in '51, and \$10,000 in '52. But since profits thereafter, State authorities feel that a small private minority is indirectly benefiting by these heavy subsidies, a bill was introduced in congress last September to make

the company wholly government-owned. This bill may have been passed by the time this is published. It is possible, too, that the company's present \$300,000 expenditures will not be decided, since its charter authorizes a maximum of \$1,500,000.

Regardless of how PLUNA's financial status is finally worked out, it is evident that the company is well on its way toward becoming the country's "Gulfstream." Survey flights using a new Douglas C-47 were recently made to Puerto Alegre and Rio de Janeiro in Brazil and to Montevideo, Paraguay. Permission for the Brazilian run was easily obtained, since VARIO has been operating into Montevideo for many months. However, the flight to Montevideo was made under circumstances that reflect upon the strength of the Argentine government. Early in 1948, FAMA was given the right to open Uruguay's territory as an en route in London in an agreement "Argentina's agreement." Notably Uruguay felt that a reciprocal courtesy would be granted PLUNA on its flights to Montevideo. With no reply was made to their request, surveys were flown without this permission.

Dubois then took ground measures of PLUNA, also realized recently a new domestic circuit, in the eastern portion of the country, that will at most double present internal route mileage. No large cities are located here, but the line will tap the rich banana district where the good roads have been laid. The 200 Congress now being drafted for this route, for they have been found suitable for operating into poor fields.

The extended question of exports is a serious one in Uruguay. Exporting Montevideo's old Melilla airport and the new airport at Carreras, 15 mi. east of the city, there are no fields suitable for more than light aircraft. PLUNA will soon put into service two new C-47s that are now being converted to company class at Melilla, but

there are many who believe these ships are much too heavy for the airports being used. For example in Buenos Aires the border area DG-2s are forced to land on the newly finished field and passengers are then transported to the city by bus. Congress appropriated about \$300,000 for airport development this year, but this sum is negligible considering the task. Most available funds in the next few years will be spent on Stocking Corporation International airport, the majority of which was built by the Airport Development Corp. during the war. In the meantime, PLUNA has hired former ATC Capt. Richard Lewis to train new flight crews for the C-47s and DG-2s.

Both CAUSA and PLUNA have been handicapped by an extremely low airplane utility rate. This is caused in part by not flying on Douglas and by the absolute lack of night operations. However, ever self-reliant, but maintenance facilities, and an inadequate meteorological service have been large contributing factors. Given such assistance as two recent trips per day to Buenos Aires, weather ground tag, low fuel costs CAUSA to keep one Stocking plane flying last in steady course.

PLUNA's operations have also been handicapped by poor load factors, averaging about 65% on the DG-2s. This rate is expected to drop even lower with the C-47s if the current campaign is not air travel in the public faith. But they are trying to make it successful. An example of the efforts now being made in this direction was observed recently after weather had permitted regular passenger service for two days. A bride in St. Louis was to have her wedding quaffed at her dress and veil were not delivered in time, so one of the small DG-2 planes was dispatched with the bride and arrived just one hour before the ceremony.

This government has placed still another load on the surface in the form of heavy demands. The basic domestic passenger rate of about \$100/ton is decreased in the following manner:

Members of congress 100%, military personnel 50%, government and agents 50%, DAG newspapers 100% (DAG corresponds to CAA), miners 25%, bonded traveling salesman 25%, and private and student pilots 30%.

The special rate given to pilots is extremely new; it is part of a program which has increased the number of registered pilots from 88 in 1940 to 1,804 in 1946.

Thus it appears that the Uruguay is heading for a completely national air transport industry. If the system proves successful, it may possibly

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At a point five miles from the target, the "mother" plane would send the Bat at a Jap ship and release it. From then on the Bat automatically followed every twist or turn of the enemy ship—until it crashed into the sinking Jap.

Used against Jap destroyers, tankers, pocket boats—and land targets—Bat—this weapon was so effective the enemy thought we had a suicide pilot inside each Bat.

In fact, the Bat contained revolving radar gear to search for the target—and ray gyroscopes to correct for error in flight.

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"Mother" plane releases radio-guided Bat, releases it and sends away from enemy ship directly for the pilot ahead.



Automatically following every change in course of enemy ship—after the first few seconds—this radio-guided Bat automatically sends away from enemy ship directly for the pilot ahead.

was a precedent among other South American republics.

Bolivia

Now that Bolivia's (relative) political situation has calmed somewhat, observers in La Paz believe that the national outlook is brighter than ever before.

Even in the bloody July revolution, government support for civilian officials through a mass of political meetings. No definite policy to guide national development had been evolved and most funds earmarked for training or for airport construction disappeared. Quick to exploit the situation, the present government changed the picture entirely by giving top priority to a long-range program of strengthening the nation's economy with air transportation.

Plans being drafted now provide outlined by Capt. Gerardo Pal, Chief of Civil Aviation, and they include the following points: (1) Improvement of ground facilities, (2) improvement of military air training program, (3) promotion of private flying through new clubs, and (4) encouragement of profitable growth in aerial hauling.

To understand the difficulties which face the development of this program and to appreciate the importance of its success, one must examine the country as a whole. Bolivia is not called the "roof of the world" without reason. Most of its population and all industry are concentrated on the flat narrow coastal strip along the sea. Two million people live here. La Paz itself sits at 12,000 ft. in a valley protected by steep sides and wide blasting off nearly every several miles.

On the other hand, the entire population of the country—the Bolivian Chaco—is flat land, potentially the perfect supplement for the other side. Until now, lack of transportation between these regions has forced Bolivia to import most of its food and other necessities. But since the sea and the cities are now producing surplus goods, the way is open for the two to compete in world markets, the said fact still reflecting in greater than ever.

Some improvement of this situation is expected in the way of a new highway the U. S. is helping to construct between Santa Cruz and Cochabamba. However, the road is only about half-completed and it will be decades before adequate ground transportation is available in this area. Meanwhile, the government feels that aviation can play a key role in helping about half the way.

First point in the government's new program is to build airports near customers, thus helping establishment of new air routes. Actually, the problem isn't that simple since there are only two good airports in the country—at Santa Cruz and Cochabamba—both controlled by the Airport Development Corp. With national requirements available and possibly aided by U. S. loans, improvements will be started at such strategic points as Guayaquil, Sucre, Reyes, and Oruro.

This last town became important during the war as the center of Bolivia's new rubber industry. Work will consist chiefly of improving present strips and installing control aids and meteorological equipment.

As an example of what can be done even with present facilities, officials point to the air transport during of Comodoro Boliviano de Yacabaya. This organization, also director construction of the new highway, recently started a cargo service with three Curtiss Commanders. Touchdowns from the beach are being flown directly to La Paz, and many cargo runs from the mountains to the lowlands are being made.

As a result of this service, a lightweight boat is being constructed to operate in the field at night so that such need can be stopped daily by air.

The other three points of the government's program are mainly part of the very slight effort to make Bolivia's

population scattered, thus supplying prospective customers and personnel in the expanding industry. Since emancipation of the Air Force in 1923, flight training has been reserved for education of the military academy. A new strip only for aviation of adults from school and secondary school graduates and, furthermore, provided that all training be conducted in Bolivia.

At the present time, students are encouraged after some months of study in Bolivia at Santa Cruz, then are sent to the U. S. to complete their course. In the future, better training will be given at Cochabamba and at the national training at La Paz. The military school of La Paz is also due for expansion under the new system; it is now open to boys and girls to attend regular schools. The course has been extended to five years and includes such elementary subjects as reading and writing.

After this in Bolivia, we get a brief history when the La Paz government by Jorge Duvalde, took delivery on two surplus Curtiss BT-10 The Bolivian Air Force is handling all maintenance work for the club and military pilots will now be furnished for a regular course of instruction. Other clubs at Cochabamba and Santa Cruz are being supplied. Air Force equipment will then be able to purchase planes of their own. The government is also interested in promoting the low-cost private club and weekly and low-cost flights to travel for instruction. Several American and Argentine glider designs have been selected and students will be able to build their own in Air Force shops.

The new private club and flying school, Bolivia's younger generation, will be a source of useful building, recently added to secondary school curriculum in La Paz, was given with enthusiasm. Numerous local clubs have been organized throughout the country, and the government is helping—by flying in birds from the jungle, by distributing pamphlets and magazines, and by financing transportation to meet costs. Last September, a national meet was held at Cochabamba for 20 regional winners. Lt. Col. Claudio Loren, commander of the Cochabamba Air Base, handled the prizes, and a large crowd watched the event.

While there are real problems to be faced in financing this air expansion program, the vision and energy with which it has been supported seem to assure that success. However, success, Bolivia's peaceful future may be, aviation will continue to play a leading role in the country's economic development.

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A ALMA Douglas DC-3 at Mollin airport. Mollin is a leading coastal city for the area.



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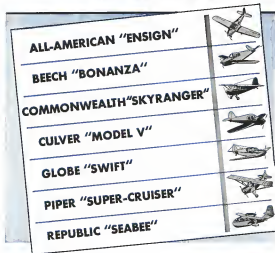
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MAINTENANCE

Maintenance Planning For New Aircraft

By RICHARD M. ADAMS, Pan American World Airways

Here are the steps which Pan-American has already taken to ensure smooth, efficient integration of two new aircraft types. It is a planning example applicable to small as well as large operations.

THE PROBLEM of putting a fleet of new aircraft in operation presents many problems which must be solved if effective use is to be made of the planes. Present day commercial transports are expensive and complex units. To get a reasonable return on the investment, a real job of planning for all phases of operation must be worked out. In no phase is this more important than maintenance of the aircraft.

Maintenance specialists must be prepared for new problems in air craft design, such as pressurization, complex hydraulic systems, new more complex electrical systems, new accessories, larger and more complicated power plants, different structural designs, longer take-off distances with a greater variety of factors, and a host of other changes.

Plans must be selected, new tools and equipment purchased, spare requirements analyzed, and manpower needs met. Every effort should be made to insure that the airplane is in the best condition design-wise that it can be, to eliminate as far as possible expensive design periods. There are a few of the problems which should be solved before the airplane enters—problems which usually are not effectively well solved for efficient operation until some months or even after operation has commenced.

In its approach to planning the Republic Executive and Boeing Stearman transport airplanes in operation, Pan American World Airways has determined to do a really thorough job of preparation. This article will outline the approach.

Basically the problem we are looking into has four parts: first, preparation of the aircraft for maintenance, second,

preparation of maintenance for the aircraft.

It has long been Pan American's policy to set up a resident engineer's office at the factory of a manufacturer who is designing or building aircraft for its use. The resident engineer reports to the vice-president and chief engineer and represents Pan American at the factory, working in its liaison efforts.

His duties and responsibilities are large and varied, but among them, preparation of the aircraft for maintenance is one of the most important. He and his staff are intimately associated with the airplane from early in its design stage until the physical airplane itself is finally delivered to the operating division. In working with the design engineers, every effort is made to build into the aircraft the results of the operating experience of the airline. The resident engineer helps clarify the balance between optimum performance and optimum maintainability.

The best performing design's down is of no value if it can not get out of the maintenance shop. Rate of availability, for example, is a factor too often overlooked. Desirability is sometimes sacrificed for weight or cost. Feasibility and desirability are not two often very different ideas when performance must be high. Interchangeability of parts in systems and between systems and installations is rarely considered. Ease of replacement is hard to keep in mind when space is at a premium. The value of built-in troubleshooting is seldom fully appreciated.

While the all important inherent safety of operation is never considered, the simplest, best equipment is an extremely valuable asset to have even

when designs have been severely tested to a certain extent. Last but not least, facility of efficient ground handling has been overlooked in almost every winged creature and creature from the pigeon to the airplane.

All the aforementioned "abilities" apply to the complete design—from the substitution of a power plant or an entire electrical system to the installation of wall paneling or a door handle mechanism. It takes only one malfeasance to keep an airplane on the ground. An hour's delay replacing a badly abused jet is just as expensive as an hour's delay replacing a nose wheel tire.

Thus the resident engineer and his staff must see that the resident possible degree of serviceability is built into the original aircraft. This is the important first step.

The second step, that of preparing maintenance for the aircraft, is one which has been assigned to the more intensive planning group. Hereafter this responsibility has been divided and shared by the vice-president and chief engineer's office, the resident engineer's office and the staff of the maintenance department in the operating divisions. In preparing for the Republic Executive and Stearman, it was decided that following maintenance staff on this phase will pay off.

The maintenance planning group has therefore been organized as a temporary staff in place to assist in part of a team which is working on all phases of the preparatory period, including communications, the flight operations, traffic, stores, parking, etc.

The policy followed in forming the unit was to staff it with men directly from the operating organization. Assignments are temporary, they will terminate approximately when these particular aircraft are put into operation. At this time the members of the team will return to the operating groups and participate in making their phase effective. This procedure should tend to maximize the purely theoretical approach by the planning group and allow the plan to be followed through to fruition with complete support from



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the system's opening drawings. Problems being solved by the airplane planning group over a wide field. For a closer delineation the group was formed into sub-units. Each of these sub-units concentrates on its particular portion of the problem, yet work closely together to provide an integrated result.

The facilities planner is concerned with ensuring that adequate space of the proper type will be provided for the operation of the new aircraft. Hangar, office, overhaul shops, and spare parts requirements are re-evaluated, both for size of area and the relative location. Layout of the facilities within the space is studied and the best type of overall pattern planned. The actual design of the buildings and grounds is not the responsibility of the planner; the design departments of the divisions affected and their contractors are responsible for this job.

The facilities planner in the maintenance planning group is concerned only with maintenance requirements and therefore acts as a specialized advisory capacity to the design departments in the plant only. His responsibility is to tell the design departments what the maintenance group regards as the requirements for satisfactory basic. As part of this consideration, studies are reviewed on airplane base location, geographical and with respect to the spending money as well as the desired layout of the maintenance base over the site selected.

The tools and equipment planner is responsible for securing that plans are released for on-time procurement of all the maintenance tools and equipment required for the operation of the new craft. These plans cover the new base and the old station. They assure the design of major service items and ordering of specialized workbenches. Overhaul and test equipment for the overhaul shops must be thought of, as must maintenance shops, and always planned before operation begins. Besides the plans for all maintenance services and overhaul requirements, plans must also be made for ground handling equipment pertaining to maintenance. Finally, spare parts and maintenance procedures must be set up for the aircraft staff.

Spare parts for the aircraft and its components are coordinated by the spare planner. One year's initial provisioning is ordered for all component parts of the plane and for the thousands of overhaul parts required in the shops. Major performance on the aircraft components and parts are

headed by a provisioning team, which assists in the aircraft maintenance plan and studies the design and operation of main parts to determine ordering quantities.

This team is made up of members of the resident engineer's staff, the maintenance engineering staff of the planning group, the spare planner, a representative from system services of supply, and a technician who is a member of the chief engineer's staff. This team secures authority of approval and general thinking between the provisioning efforts on all new aircraft. The spare planner is responsible for delivery through the specific aircraft.

The spare planner acts as executive vice chairman for the particular aircraft type. General ideas and preliminary planning are applied to the provisioning effort, both by having members of these departments on the resident engineer's staff, and also in the spare planner's office. Once the quantities for the original order have been determined, the purchasing department carries on the normal process of purchase orders and follow up. It is, however, usually the responsibility of maintenance to determine the original provisioning.

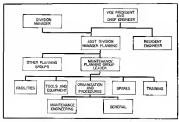
Based on the frequency and exact needs over which the aircraft will operate on, not always presently known at the beginning of the provisioning effort, an accurate number of stations is used in preliminary provisioning. Stations are classified as main base, sub-base, mobile, and, in, or C-type stations. The station classification is determined by the type of maintenance service

likely to be performed, also by trip frequency. In these a mobile or portable machine is used to include extra A, B, or C-type station quantities when the main pattern has been previously set. This same procedure is used in tool and equipment provision.

Installation of order quantities for overhaul parts in connection and other components is usually not contemplated at the main provisioning team meetings at the aircraft manufacturer's plant. This portion of the work is generally handled between specialists on the maintenance engineering staff of the planning group, and the technical manufacturers of the components, initial purchase orders being processed by the provisioning department. However, they still continue to be coordinated by the spare planner and provisioning team chairman.

Task of adequately training a large maintenance organization is the responsibility of a new large commercial aircraft is a big one. Planning this part of the program is the responsibility of the training planner. Sublets and curricula are laid out for training at the aircraft factory, the airport factory, and at some of the more complex academic facilities.

Bulk of the training is, however, performed at the main base. Courses must be laid out, instructors trained, manuals ordered or built, and a detailed program for the total training course designed. The program must be so designed that a sufficient number of personnel are trained before the aircraft is operated efficiently, yet the number of persons assigned to classes cannot peak



Organization chart of the Aircraft Division planning group concerned with maintenance planning for new aircraft. This organization is developed for planning, responsibility for integrating design, construction and repair facilities into one team effort.

to the point of unduly affecting current operations. Courses generally will start at the same hour approximately 3-6 mo. before arrival of the first cassette. Fee-bury sessions start earlier, in some cases, in order to train instructors and to prevent peak training loads.

Possibly the most diverse series of functions is given to the organization and procedures planner. Part of his staff is made up of the membership skinning team. Other members with extensive shop experience and planning experience make up the rest.

Continuum vs. Periodic Service

Their functions include setting up servicing patterns for the coast, including time limits at which the prescribed services must be performed. Analysis is made to determine whether continuous maintenance or periodic overhaul is the best policy for the particular equipment. Studies are made of each component of the arrival to decide whether it should be overhauled in Pan American ships or whether the work should be subcontracted.

The management organization is responsible for the survey in order to make sure it is properly set up for the changes brought about by the new aircraft type. Once the organization plan is decided upon, responsibility will be set for the various types of work to be performed. For instance, more and more electronic equipment is being installed on new aircraft. For each component there must be a decision as to which of the shops—radio, instrument, electrical, accessory—will be responsible for its removal. Once the decision is made, the required equipment, space, training and tools will be provided.

Most power requirements for machinery, servicing crew, utilities, and other functions are forecast so that steps may be taken toward buying and training the personnel. Cost studies and estimates of performance are made to allow reasonably accurate predictions of operational costs and aircraft utilization which may be expected during the five months of operation. Rough standards are set for servicing after sleep-out time and at overhaul times, servicing each of several aircraft per day, and the maintenance crew size for each set.

Every component on the aircraft is studied in detail, and provisions are made for instance in the maintenance manual of every known piece of industrial measuring equipment, installation, removal, servicing, overhaul, as trouble shooting of the various components. If adequate information is not available, service test runs are arranged, if possible, to procure the information.

In other words, an effort is made to

get—before the surprise arrives—that information which is usually not obtained without costly delays in service. Generally it is not properly obtained even then, because of the price of other equally urgent problems.

Finally, standard forms and procedures must be prepared for the particular aircraft. All services and work load forms, flight engineer's sheets, etc., which must be used will be designed, and instructions for their use will be issued.

Standard "best way" job methods for doing repetitive jobs will be worked out and set up before the new craft arrives. These methods will be used during the training program, even up, as early as possible, teaching of the "best way" the first time.

All of the planning group's work is in close union with existing operating groups. It is mainly the responsibility of the planning group to see that the planning job is done, but this does not relieve the operating group of responsibility.

It is only by so working in unison that the revolving plan will have the wholesome support of every one concerned, and will embody the best thoughts of the maintenance department. A plan, no matter how well thought out, is of no use if those who carry it out feel about it as you may feel about it.

Early Motives, Fall Page 98

Naturally, each detailed planning costs money. It must pay off, and I doubt anyone who has been closely associated with the results obtained when an organization which has not been prepared receives a new flow of interest, need not stretch his imagination to see what could have been done to eliminate the extremely costly confusion which results.

Exposure of the military forces resulting in punctureably detailed planning for major operations, has been streamlined often enough to be of similar or more so. But a more solid, understatedly comprehensive might be made with a man who is told to deliver from New York to San Francisco in mid-afternoon without checking his car parking lot bag, making reservations or consulting any maps. If he can suddenly handle for the entire war, and into enough dimensions, and if he can think about his own, he will probably think it more day, but the cost, the

comparably higher than if he had first taken out a day to plan his trip.

Benefits to be derived from planning for maintenance are emphasized by contrast with cases in which such planning has not been applied. Unfortunately, examples of non-planning are not rare. Consider, for instance, the engine malfunctions which require disassembly of the engine starter in order to remove it upon failure—and compare it with the well-thought-out design which allows free and easy access to all accessories.

Adequate space for all phases of the spectacle would seem to be a simple and obvious thing to plan for. Yet the present seriously attempted conditions of a huge number of our sports affect to how badly it has been neglected, both on the loading ramps and in the maintenance areas. Delays running into hours, also flight cancellations, have been a direct result of this oversight.

Delays, damage to expensive parts, and untoward injuries to workers result from the lack of proper tools and equipment in proper supply. It is possible for an explosion to be held up several days at a distant station because of the lack of a single specialized, but commonly used, tool. Yet we know these needs can be foreseen.

Huge amounts of time can be saved by training. Properly trained men do the job correctly the first time and in a fraction of the time required by untrained men. The tremendous cost of doing skilled work with unskilled men is well recognized.

As for *organization and procedure planning*, a few specific examples may clarify the point. It is basic that if there is no efficient response, the job will pile up and deliver results. When poorly thought out, procedural rules are not followed, time wasting is confusion and lost time. Poorly organized team effort will not produce results. Streamlined work methods have in the past reduced man hours on an engine service from 120 to 18, slipped hours on a rigging problem from 70 to 6, and prevented engine loss from 2 to 14.

When it is considered that the average power of a present day diesel engine plant is in the neighborhood of \$5,000 to \$15,000 per day, the value of saving operable plant-days is evident. The consideration of all the benefits and savings that good pre-planning for maintenance can effect will show the difference between high and low utilization, low or high operating costs, no current profits, versus a possible on-line performance or benefits, departs, a profit or a loss—in short, success or failure.

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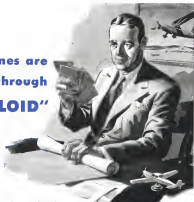


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New B. F. Goodrich assembly gives maintenance men a break

THE Bessif International Airways mechanic doesn't do the prone, uncomfortable crouching of the average maintenance duster. He's just cranked a B. F. Goodrich Expander Tube buster. The mechanic likes the buster because he doesn't have to use the whole thing down to replace the brake lining, and he doesn't need a lot of special tools to do the work.

The engineers at Bessif like the assembly's low maintenance cost. There are two reasons why that cost figure is so low. The buster needs no maintenance when it is in the shop, and it is in the shop less often than other type busters.

One reason for this is that a hydraulically operated tube forces brake blocks against the brake drum *only* all the way around. This results in powerful action with maximum pressure and minimum wear.

The designer likes the simplicity of design for another reason. The B. F. Goodrich Expander Tube buster can be made lighter for a given amount of

horsepower than any other type buster. From the Lockheed Constellation to the Piper Cub, this advantage has proved itself on every type of modern aircraft.

B. F. Goodrich Silvertown tires, wheels and brakes are now sold as a complete assembly—as a package new service to airlines and to manufacturers. The B. F. Goodrich Company, American and Division, Akron, Ohio.

B.F. Goodrich

FIRST IN RUNNERS



Floor-Fit Electrical Receptacles Protected Against Short Circuits

These spring-loaded caps on electrical receptacles in FAA's Atlantic Div. longer floor pits successfully exclude water and dirt vapors, to sharply reduce the source of short circuiting. As result of installation, maintenance repairs on receptacles have been decreased to 25% of former requirement, with yearly savings approximating \$1,000. Improvement was suggested by James Kilgus of Rite's machine shop.

Efficient Spray Equipment Cuts Floor Working Time

This 55 gal. pressurized drum with hose and spray gun is effectively used for washing down aircraft at FAA's La Guardia Field base. Method was installed to replace suction type sprayer involving use of 5-gal. cans, which required frequent filling and holding at spray level.

New equipment, allowing extended time saving of 200 hr. per month and each saving of \$2,400 annually, is idea of Joseph Zarbo of Rite's sheet service unit.





SOMETHING *New* ON THE NOSE



OF THE *New* SUPER CRUISER

Crowds thronged around the new Piper Super Cruiser at the great National Aircraft Show.

They thronged, too, at the Sensenich booth where a demonstration engine model of Sensenich Brothers new SKYBLADE was being shown for the first time. Engineers, designers, pilots praised the simple, practical design of this lightweight, two-position controllable pitch propeller.

New purchasers of the Piper Super Cruiser can enjoy either the propeller

performance of a Sensenich fixed pitch propeller which is standard equipment or the new controllable variable as special equipment. It's just a matter of changing the prop.

For more than a quarter of a century Sensenich has concentrated its production on high quality wood propellers only. There is scarcely a pilot who hasn't flown behind a Sensenich. This proof of performance has made Sensenich Brothers the world's largest manufacturer of wood aircraft propellers.



A and B RECOMMEND If you are interested in obtaining a three-day course covering the assembly, disassembly, balance and inspection of Sensenich SKYBLADE propellers at our Lancaster, Pa., plant, please write us.



REPAIR SERVICE: If your wood propeller needs regluing, send it to the Sensenich PROP SHOP. Any work. Prompt and efficient service. Cover and "Vat" planes are Glendale plant.

SENSENICH BROTHERS • Main Plant, LANCASTER, PA. • West Coast Branch, GLENDALE, CALIF.

announcing
the **1947** Yearbook Issue
of

the industry's most complete,
authoritative and up-to-the-minute
source of basic reference material on
United States and foreign
military, commercial and personal
aircraft and engines

Aviation's Annual Yearbook Issues have long been regarded as the basic source of information for all types of military, commercial and personal aircraft and engines. The 14th Annual Edition this year will continue to be the largest collection of facts, figures, data and specifications on foreign planes that has ever been assembled.

Aviation's 1947 Yearbook Issue will be used daily as a standard reference source of valuable working information by men of management, design, engineering, research, production, purchasing — by those men who represent the buying power of the industry. Its continuing value makes this issue of AVIATION a MUST on any thoughtfully scheduled advertising program. NO INCREASE IN ADVERTISING RATES. Write or wire your reservations at once.



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AVIATION, February, 1947

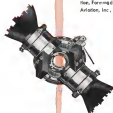
AVIATION, February, 1947

THE Navion AND THE Seabee

**GAIN POWER, RANGE and MANEUVERABILITY
with the HARTZELL HYDRO-SELECTIVE PROPELLER**

The Navion, a big, sturdy, 4-place plane with plenty of luggage capacity, and the Seabee, a roomy, all-wood 4-place amphibian, are setting new high standards in the field of planes built for business and pleasure. And their superb maneuverability—their speed—their economical cruising—their quick take-off ability—is gained with the Hartzell Hydro-Selective Propeller. With this new propeller you can, to a great extent, control flight characteristics as you fly. Shorten take-off run if necessary. Increase maximum speed as needed. Cut fuel consumption. The performance changes needed as you fly are at your fingertips.

You'll like the Hartzell Hydro-Selective Propeller, and you'll like these two planes. Investigate them. The Seabee is made by Republic Aviation Corporation, Farmingdale, L. I., New York; the Navion is a product of North American Aviation, Inc., Los Angeles 48, California.



The propeller built largest steel hub shown at the left is the heart of the Hartzell Hydro-Selective Propeller. It is hydraulically operated by means of a simple push pull action on the "feature control" control valve of simple design has only one moving part. Hydraulic mechanism does not require control by engine oil pressure. Hydraulic system on high pitch control pressure is applied. The selective control is actuated through a series of valves, simply set the control—pitch change is free, automatic and precise. Blade of solid aluminum, one weather proof through and through. Hydraulic oil light or weight, yet has the highest strength weight ratio and the highest resistance to changing qualities of any synthetic material yet developed. Characterized by the Hydro-Selective Propeller is a replacement will be available before long.

HARTZELL PROPELLER CO.

DESIGNERS AND MAKERS OF AIRPLANE PROPELLERS AND ENGINE TEST CELLS

480 HEITZMAN AVE., PIQUA, OHIO, U. S. A.

Spun Glass Cord Lacing Effective for Kettle Hoses

•In order to save maintenance men hours, TAI employs Owens Corning Fiberglas cord to line wiring harness of two way radio communication unit. Used to replace linen cord, which was affected by heat and high humidity, spun glass material is treated with lacquer to facilitate lacing during long operation.

With use of new cord, time saving at Air's Cheyenne maintenance base is estimated at 400 man-hours yearly. Procedure was suggested by Warren Kosh, mechanical helper at Cheyenne.



Retary Hearth Oven Speeds Cylinder Overhaul

•To facilitate installation of valve guides, spring lockups, and valve seats, this oven recently designed by Rockwell-Downs Corporation of Southfield, Michigan, and Carl Magnusson engine shop firm.

Unit has rotary hearth accommodating seven cylinders. Hemisphere control for automatic positioning of side dogs, pneumatically operated foot pedal for door activation, and machine mechanism operating to heat up cylinder with door by affixing one several hearth turn for one turn of crank.


Proven chamber old method of using lathe in heat cylinder, involving at least 1 hr. installation time for valve guides. With one unit, only 3 min. are required to remove seven cylinders and install guides.

World's largest line of


Whatever your production needs, you can select exactly the right equipment from Chicago Pneumatic Tool Company's wide range of Pneumatic, Universal Electric and Bicycle Electric tools.

These include Riveters, Riveting-Diaphragm Machines, Drills, Impact Wrenches, Screw Drivers, Nut Runners, Grinders and Sanders, Tappers, Finishing Tools, Safety Belancers; also Air Hoses, Couplings and Nipples.


PNEUMATIC AND ELECTRIC AVIATION TOOLS




SLOW-HITTING AERO RIVETING HAMMER
CP Slow-Hitting Aero Riveting Hammer delivers just the right impact to insure properly driven rivets.



IMPACT WRENCH
CP Pneumatic Wrenches, impact type, speed the application and removal of nuts and screws.



UNIVERSAL DRILL
CP-806 Universal Electric Drills are designed for close quarter drilling.



PNEUMATIC DIMPLING MACHINE
This electrically controlled machine assures precision cold dimpling of aluminum and the harder aluminum alloys.



**CHICAGO PNEUMATIC
TOOL COMPANY**

General Offices: 8 East 44th Street, New York 17, N. Y.

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINE
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AVIATION, February, 1947

Setting the Pace...

IN AIRCRAFT FINISHES

GLIDAIR AIRCRAFT PRODUCTS DISTRIBUTED BY...

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- SUPPLY DIVISION, INC.
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The Glidden Company is in aviation to stay, proving it by devoting all its resources to perfecting better finishes for every need on every kind of plane. You don't spend over 29 years satisfying the finishing needs of all kinds of industries without achieving the "know how" to successfully serve another. And that's the story behind the outstanding quality of Glidden Aircraft Finishes by Glidden! For these quality Glidden products—for expert help on any finishing problem, see your nearest Glidden Distributor or write Glidden Headquarters.

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GLIDAIR FLYING COLORS



Made by Glidden Racemaker in Paints

AVIATION, February, 1947

109

THEY MUST BE TOP QUALITY OR THEY MUST BE SCRAPPED



There is only one standard of quality in TRU-LAY Aircraft Cable and TRU-LOC Terminals. If they pass our rigid inspections, they're as good as we know how to make them. If they don't, they're scrap. "B grade" or "seconds" have no place in this business of making controls for the Aircraft Industry.

DETROIT, MICHIGAN—American Chain & Cable originated swaged terminals and the preferred cable that makes them possible.

Perhaps that is not important in itself. But it means that our engineers have been working close to the aircraft industry almost since its beginning. As improved airplanes demand improved cable controls, we anticipate such demands and meet them.

In short, you can always depend upon TRU-LAY Cable and TRU-LOC Terminals. They've always been dependable—always will be.

If you do not have copies of our file literature, write our Detroit office.

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In Business for Your Safety

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**AUTOMOTIVE AND AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE**

Lightplane Anti-Fire Unit Means Extra Safety

Special Kifle carbon dioxide system, installed in Ercoppe and to be installed in other lightplane and business flyers, gives thorough protection.

A CATION-FIRE fire extinguishing system that says to the Bureau of Aeronautics that it is a standard packaged system of personal planes has been recognized by Walter Kifle & Co., Sellersville, Pa., and installed in an Ercoppe.

Owners of the craft, Cragg and Leland Walsh of Madison, N. J., combine business and pleasure in their flying operation of the Walsh Engineering Co., Elizabeth, N. J., specializing in airplanes. They rely heavily upon the Ercoppe for business trips.

Cragg Walsh, witnessing fatal accidents and tests, commented, "We're just making use of the safest planes ever made. Neither my brother nor I have ever experienced a plane fire, but

it would be uncomfortable to put it mildly to have one. If a fire protection system is possible, it's just plain common sense to install it."

Several months of working testing of various designs preceded the actual installation, which weighs about 26 lb. Several components consist of a special lightweight pressure cylinder containing 5 lb. of liquid CO₂, under pressure, a pull-release handle, and piping leading from the bottle to strategic spots in the engine compartment.

Cylinder and release handle are located in the cockpit, and piping leads through the firewall and branches out to cover the outlets in front of the air intake, the air scoop, air duct, and carburetor intake.

When released by the pull handle, the CO₂ gas rushes through the piping and out perforations or discharge holes, where it expands to 150 times its stored volume. Resulting into every corner of the engine compartment, this tremendous volume of inert gas displaces oxygen, depriving the fire, smothering flames in a matter of seconds. After accomplishing its task, the gas expands, it leaves no tell-tale residue, and it does not harm engine or fuelage in any way. Piping in the carburetor intake acts as a small nozzle (rather than perforations) which leads carbon dioxide more effectively to the vital spot.

A convenient check prior to flight is made possible by installation of a visual-type and door in the fuselage skin near the cockpit. Connected to the safety release of the cylinder by small dia. tubing, the fitting will blow out, permitting continued flow of the CO₂ when excessive temperature rises pressure in the cylinder to 2,650 psi.



New Kifle fire extinguishing system is fitted in Ercoppe cockpit. Details are: (A) Pull release handle, (B) control and low discharge (C) 5-lb. bottle of CO₂, (D) piping to carry CO₂ to engine and (E) outlet to pressure relief slot.



Piping from carburetor-mounted CO₂ bottle is shown as disposed in engine compartment. (A) is fitting to outlet of bottle piping, (B) runs forward of bottle plate, (C) is reduction system, and (D) to carburetor intake.

AVIATION, February, 1947

CLEVELAND, February, 1947

GENERAL CONTROLS in the Spotlight!



Unsurpassed *rig* valves for aircraft

- *Tubecraft* is a... —Indicates positive operation in
- any position regardless of... —vacuum, change of position, or confirmation,
- extreme pressure, temperature... and flow controls for every aircraft application
- Conspicuous Light Weight—Tight Seal Off... High Flow with Low Pressure Drop • Long Life
- Outstanding performance and reliability... means maximum and accurate safety
- General Controls work worldwide... for complex specifications, repair
- are Casing 11C form... secure factory finish,
- as well as... as factory

GENERAL CONTROLS

Manufacturers of Aircraft Hydraulic Control Valves
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Aviation People

Alfred Marston (right) has been made chairman of board of Republic Machinery Corp., the second company in 10 to v.p. Henry in position, for work achieved as a mechanical engineer. He has over 200 patents to his name, and is a member of Board of Governors of ASA, an associate fellow and director of SAE,



A. Marston

M. I. Peala

president of Wagon Club, and a member of SAE. Henry E. Peala (left) has been elected president of Republic Machinery Corp. Formerly v.p. and general manager, he directed company's business for 10 years. He has been a member of many clubs and societies, including the American Society of Mechanical Engineers, and is a past president of the Tulsa Chapter of the American Society of Mechanical Engineers. He has been a member of the Tulsa Chapter of the American Society of Mechanical Engineers, and is a past president of the Tulsa Chapter of the American Society of Mechanical Engineers.



A. Farwell

H. M. Finkler

and J.P. 15. Born in Russia, he received his education as an auto engineer in Tulsa. He is affiliated with International Aviation Association, Society of Automotive Engineers, Wichita Engineers, and is a member of SAE. Marston W. Finkler (right) is v.p. of Republic. He has been a member of many clubs and societies, including the American Society of Mechanical Engineers, and is a past president of the Tulsa Chapter of the American Society of Mechanical Engineers.

A. J. Woodhark, Jr., president of The Woodhark Co., Cleveland aviation parts firm, has been elected president of Aviation Distributors & Manufacturers Assn. He is well qualified for this post.

TRUARC trims 13 minutes machining to 6

cuts new exhaust fan bearing unit

- 25% in weight
- 66% in assembly time



Circle 10, S. E. W. Co.

Use of Waltes Truarc Retaining Rings permits housing redesign—eliminates heavy cast bearing caps and screws requiring drilling and tapping; lowers labor and material cost.

"TRUARC PAYS DIVIDENDS IN SAVINGS" declares M. & E. Manufacturing Company, of Indianapolis, makers of exhaust fans for industry. "Improvements in design made possible by Waltes Truarc Retaining Rings provide a quieter, longer-running assembly, assure longer life to the entire unit, eliminate the hazards of excessive unnecessary pressure on the bearing and maximum future service requirements. In our experience Truarc has definitely proved itself the better method for doing an important job."

Truarc does a better job on axles and shafts for retaining and positioning wheels, pulleys, cones and gears. In widely varied applications, designers find its never-failing grip, its patented design that assures constant consistency, make Truarc the better way to hold machine parts together. Production and maintenance men in many industries see how Truarc rings cut costs sharply, maximize accuracy, ensuring relationship of parts. Send us your drawings. Waltes Truarc engineers will be glad to show how Truarc can help you.

WALDES TRUARC

A W. W. RETAINING RING CO. INC.

RETAINING RINGS

*** Send for new Truarc booklet, "New Development in Retaining Rings" ***

Write: Waltes Truarc, Inc., 4710 Astor Place
Long Island City 4, N.Y.

Please send booklet, "New Development in Retaining Rings" to:

Name: _____

Title: _____

Company: _____

Business Address: _____

City: _____ State: _____

WALDES ROBINSON, INC., LONG ISLAND CITY 4, NEW YORK

AVIATION, February, 1947

AVIATION, February, 1947

SAFETY ENGINEERED CONTROL WHEELS



TYPICAL DESIGNS



STANDARD DESIGNS
OR
CUSTOM BUILT

• Scott control wheels are "Safety-Engineered" and designed for exceptional strength, with durability and low weight, served to conform to the chart, providing high impact absorption—protection for the nose but possible hazard of body impact. The chart of thoughtful designers, working to improve cabin protection.

Molded and fabricated—Equipped with Telex No. 2 Flange, in only 17,800 shades to match or contrast with interior trim. A deep lustrous finish, soft and pleasing to the hand, unaffected by temperature variations.

Coverings used are not just "lastings," but are "Scott-Cut" Coverings of vacuolized strength and ductility. A choice of Scott "Safety-Engineered" Standard Models, in any color, with or without designs.

New and distinctive models can be quickly developed to verify styling desires and requirements. You will be pleasantly surprised at the low cost. Write today for detailed information on Scott "Safety-Engineered" Control Wheels.



SCOTT AVIATION CORP.
214 ERIE STREET, LANCASTER, N. Y.

A Leading Name in Aircraft Accessories.

Master Cylinders • Parking Brake Valves for any Hydraulic system • Oxygen and Instruments • Oxygen Suction-Draw • Aviation Electronics.

As West Coast manager for East 200
L. S. Hunsley, WPA, has been elected
pres. of Airline Pilots & Attendants
Conference for 1947, with A. H. Judd,
DAL, as 1st v-p, and E. A. Dink, DAL,
2nd v-p.

G. Edward Fendley has been elected as
counsel on matters and jet propulsion
for Daniel & Florence Guggenheim
Foundation.

James S. Wright has been appointed
Western rep. for IAG.

Harry B. Stinger has been appointed
as chairman of sub-air Committee
of National Federation of American
Engineers.

Ever Allen Leslie C. Stierne has been
appointed to NACA staff committee.
Represented to NACA by Dr. Vannevar
Bush, pres. of American Inst. of Aeronautics,
and Arthur Raymond, v-p engineering,
Deaght.

Dr. E. S. Swenson, senior professor of
aeronautics at Stanford U., has been
elected 1947 Frank G. Bower trophy
for most outstanding contribution to
development of air fields in field of
education and training.

Charles H. Mackintosh has been ap-
pointed as counsel for Capital Air-
lines, and Stuart E. Parker has been made
director of passenger service.

Dr. Col. William L. Kirk has been ap-
pointed acting chief of Aviation Section
of N. Y. Board of Trade.

Representatives AIRLINE v-p, station-
Max Workman with Wash. by, Gen.
Stetson, Mark Stetson, Theodore P.
Gould, with N. Y. by George Field has
accepted as dir. of pub. rel. and adver-
tising.

Unit of Public Relations stations
v-p, named are Benjamin R. Lott,
William P. Bond, William Kunkin, and
Robert Hoffman, last represents Al-
ber Airline and Independent Airline.

G. Donald Mandel has been elected
v-p in charge of planning for NACA.

Major H. K. de Graaf has been appointed
2nd. Flight dir. of Royal Netherlands
Aviation, with Lee Airline Co.

Glen H. McCarty has been elected a
director of SAE.

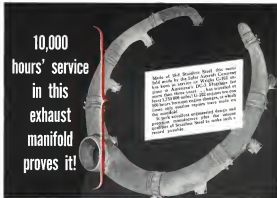
American Helicopter pilots stations:
E. E. Francis, pres. David Ferguson,
1st v-p, R. A. Anderson, 2nd v-p, R. E. Kester,
3rd v-p, R. E. Kester, 4th v-p, R. E. Kester,
5th v-p, R. E. Kester, 6th v-p, R. E. Kester,
7th v-p, R. E. Kester, 8th v-p, R. E. Kester,
9th v-p, R. E. Kester, 10th v-p, R. E. Kester.

Dr. L. Goldman has been elected associate
deputy administrator for Office of Aeronautics,
WPA.

Edward R. Vossler, v-p, and West Coast
pres. of United Service Corp., has
accepted 1947 as pres. of
United Erie Marine has been appointed
pres. of American Standard Inc.

James P. Cunningham has been ap-
pointed v-p, of Lockheed.

George P. Folsom has been appointed
pub. rel. representative for FAA in con-



-nothing equals Stainless Steel!
FOR RESISTANCE TO HIGH TEMPERATURES AND CORROSIVE GASES

In the past five years thousands of
Stainless Steel manifolds like this
have had crowded into their service
equal to dozens of cast-iron opera-
tions. Their successful performance
has demonstrated how sound was the
government directive that specifi-
cally authorized Stainless Steel "for
all plane parts that come in contact
with exhaust gases and which are
exposed to high temperatures."

Today with wartime restrictions
removed you can really use U-S-S
Stainless Steel to work. Not only to
improve the performance of exhaust
stacks, collector rings, various con-

ings, brackets, etc., but also to in-
crease the efficiency of structural
parts and control surfaces.

In alloy steels, in rubber, in
copper and stainless steels, the
strength of U-S-S Stainless will in-
crease the highest strength-weight
ratio. Its superior corrosion resis-
tance eliminates the need for making
allowances for weakening. Its ability
to better withstand fatigue, shock
and abrasion, results in longer life

and lower maintenance.

And because U-S-S Stainless Steel
has exceptional formability, can be
easily spot welded at high speed, its
use materially lowers fabrication
costs.

U-S-S Stainless Steel is available
in the most complete range of sizes,
forms and surface finishes obtainable
anywhere. Our engineers will gladly
cooperate with you in applying it
most economically.

U-S-S STAINLESS STEEL

BRIDGE STEEL • PLATES • SHEETS • TUBES • PIPE • TANKS • WIRE • SPECIAL SECTIONS



AMERICAN STEEL & WIRE COMPANY, Cleveland, Chicago and New York
CARBIDE-ILLINOIS STEEL CORPORATION, Pittsburgh and Chicago
COLUMBIA STEEL COMPANY, New Providence
NATIONAL STEEL COMPANY, Pittsburgh
PENNSYLVANIA COAL, IRON & ROBERTSON COMPANY, Birmingham
United States Steel South-Central Division, Houston, Houston
United States Steel Eastern Division, New York

UNITED STATES STEEL



Here is the **BARTOW** Beam-Controlled Unit

Bartow lighting is a system consisting of a number of high intensity units on both sides of the runway or approach. These units emit an intense high intensity without glare. They are so designed that they may be used as fixed lights with brightness controlled for average visibility conditions, or they may have a remotely controlled variable beam for more efficient operation under lower limits.

The Bartow system was developed by pilots and engineers of Bartow Beacon, Inc., and is manufactured by the Bartow Corporation which has been known for years as a manufacturer of scientifically designed aircraft lighting and other electrical equipment.

AIRLINES landings are made safely, regularly under low visibility conditions on a Bartow equipped runway without inducing present proved excessive safety standards. When, for example, reported ground visibility is given at $\frac{1}{2}$ mile, Bartow lighting on the runway increases cockpit visibility to one mile. Bartow high intensity approach and runway lights provide a powerful beam which is automatically controlled to give maximum penetration and freedom of sight under adverse atmospheric conditions. Traffic control is improved, overruns eliminated, delays and cancellations greatly reduced.

Bartow high intensity approach and runway lighting was developed by Bartow Beacon, Inc., in collaboration with well known pilots and engineers. It has been proved over a number of years of development and tests. During the war the entire production—nearly 40,000 units, went to the armed forces for installation throughout the world.

Pilots who have flown in the Aleutians, in Newfoundland and in other tough flying, low visibility areas can tell you what Bartow lighting did to help them. Reports on operations at such locations show increase in operations, with decrease in loss of personnel and equipment after installation of these lights.

It is safe to say that while you are reading this, somewhere around the world these lights are helping some pilot make a landing that would not otherwise be possible. Now Bartow units are released for civilian airports in the United States, Europe, and in other countries.

Ask Us to Send You a Copy of this New Booklet

Now available is a new booklet on low visibility landings discussing numerous visibility problems... perspective... its importance in judgment... also glare and light penetration.

If you are concerned with airport or airbase operation, and are interested in approach and runway lighting, ask us to send you a copy of the booklet, "The Light You Bring Home to." Please write on your company letterhead—no limit. Bartow Corporation, Airport Lighting Division, East Stroudsburg, Pa.



FOR: Maximum Safety • Minimum Cancellations
Minimum Passover • Shorter Landing Time • Minimum Stacking up

Bartow

High Intensity Approach and Runway Lighting...

Maintain Scheduled Operations in Low Visibility Conditions Caused by Fog, Sleet, Snow, Rain or Dust ... with Bartow High Intensity Runway Lighting

THE PROBLEM:

Bartow lighting works with, and is complementary to proper instrument and radio approach procedure. On instruments, a pilot can approach to within his specified minimum altitude and can be within 100 feet of the center line of approach, depending on the skill and confidence of the pilot, wind conditions, and the accuracy of his equipment. The actual landing must be accomplished by visual contact.

The pilot must see, not necessarily the runway surface, but its offset by lights which establish a perspective. Perspective is required for accurate judgment of altitude, attitude, direction, distance and speed.



The diagram shows that the light for the Bartow unit reaches the pilot at various angles. The beam system is so designed that at these angles the light from each

unit will be of equal value when it reaches the pilot. Glare is eliminated, and the pilot is enabled to judge perspective, location, speed and altitude.



A single light provides only good location, with no surface, flat, or perspective for judging location, direction, or altitude.



A single row of light provides perspective but no location of the runway and speed, altitude, and attitude of the plane.



Two parallel rows of light provide perspective but no location of the runway and speed, altitude, and attitude of the plane.

Bartow Lights Give Maximum Penetration and Proper Perspective Without Glare

Light beams landing the units are controlled and distributed so that all lights visible appear of the same brightness without glare to a pilot over the course of the approach or arrival.



With uncontrolled beams, surrounding fog particles are lit with high intensity, causing glare.



With proper beam control, distribution there is no glare and light reflecting from surrounding fog, and no glare.

LINE MATERIAL

AIRPORT LIGHTING

Line Material Corporation, 1000 North 10th Street, Suite 100, East Stroudsburg, Pa. 18042 • Phone: (610) 455-1111 • Telex: 155555 • Cable: LINE MAT CORP • Airport Lighting Division, 1000 North 10th Street, Suite 100, East Stroudsburg, Pa. 18042 • Phone: (610) 455-1111 • Telex: 155555 • Cable: LINE MAT CORP • Airport Lighting Division

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ALLEN FLAT HEAD CAP SCREWS

For perfect countersink-fit; positive wrenching

- (1) Flush top surface with no gap between screw head and surrounding metal.
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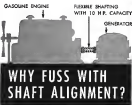
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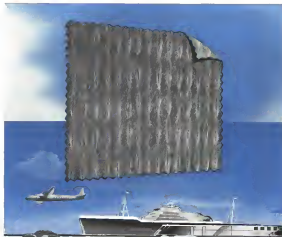
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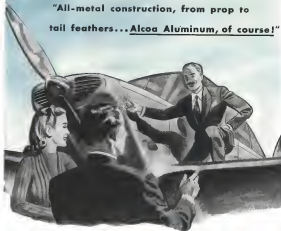
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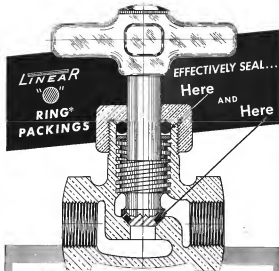
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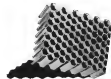
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Ashtabula Industries Corp.	143	Orchard Co., The S. P.	159	Seaford Paper Co.	199
Ashtabula Industries Corp.	144	Orchard Co., The S. P.	160	Seaford Paper Co.	200
Ashtabula Industries Corp.	145	Orchard Co., The S. P.	161	Seaford Paper Co.	201
Ashtabula Industries Corp.	146	Orchard Co., The S. P.	162	Seaford Paper Co.	202
Ashtabula Industries Corp.	147	Orchard Co., The S. P.	163	Seaford Paper Co.	203
Ashtabula Industries Corp.	148	Orchard Co., The S. P.	164	Seaford Paper Co.	204
Ashtabula Industries Corp.	149	Orchard Co., The S. P.	165	Seaford Paper Co.	205
Ashtabula Industries Corp.	150	Orchard Co., The S. P.	166	Seaford Paper Co.	206
Ashtabula Industries Corp.	151	Orchard Co., The S. P.	167	Seaford Paper Co.	207
Ashtabula Industries Corp.	152	Orchard Co., The S. P.	168	Seaford Paper Co.	208
Ashtabula Industries Corp.	153	Orchard Co., The S. P.	169	Seaford Paper Co.	209
Ashtabula Industries Corp.	154	Orchard Co., The S. P.	170	Seaford Paper Co.	210
Ashtabula Industries Corp.	155	Orchard Co., The S. P.	171	Seaford Paper Co.	211
Ashtabula Industries Corp.	156	Orchard Co., The S. P.	172	Seaford Paper Co.	212
Ashtabula Industries Corp.	157	Orchard Co., The S. P.	173	Seaford Paper Co.	213
Ashtabula Industries Corp.	158	Orchard Co., The S. P.	174	Seaford Paper Co.	214
Ashtabula Industries Corp.	159	Orchard Co., The S. P.	175	Seaford Paper Co.	215
Ashtabula Industries Corp.	160	Orchard Co., The S. P.	176	Seaford Paper Co.	216
Ashtabula Industries Corp.	161	Orchard Co., The S. P.	177	Seaford Paper Co.	217
Ashtabula Industries Corp.	162	Orchard Co., The S. P.	178	Seaford Paper Co.	218
Ashtabula Industries Corp.	163	Orchard Co., The S. P.	179	Seaford Paper Co.	219
Ashtabula Industries Corp.	164	Orchard Co., The S. P.	180	Seaford Paper Co.	220
Ashtabula Industries Corp.	165	Orchard Co., The S. P.	181	Seaford Paper Co.	221
Ashtabula Industries Corp.	166	Orchard Co., The S. P.	182	Seaford Paper Co.	222
Ashtabula Industries Corp.	167	Orchard Co., The S. P.	183	Seaford Paper Co.	223
Ashtabula Industries Corp.	168	Orchard Co., The S. P.	184	Seaford Paper Co.	224
Ashtabula Industries Corp.	169	Orchard Co., The S. P.	185	Seaford Paper Co.	225
Ashtabula Industries Corp.	170	Orchard Co., The S. P.	186	Seaford Paper Co.	226
Ashtabula Industries Corp.	171	Orchard Co., The S. P.	187	Seaford Paper Co.	227
Ashtabula Industries Corp.	172	Orchard Co., The S. P.	188	Seaford Paper Co.	228
Ashtabula Industries Corp.	173	Orchard Co., The S. P.	189	Seaford Paper Co.	22

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2050	2050	2050	2050	

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HEX TOP SPIN OUT

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HEX TOP SPIN OUT

Slip-on over edge of panel for sheet metal. Hex top, welding, riveting.



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Slip-on over edge of panel for sheet metal. Hex top, welding, riveting.



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